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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XIX.—FROM CREATION TO EVOLUTION.

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PART IV.

THE FINAL EFFORT OF THEOLOGY.

THE Origin of Species had come into the theological world like a plow into an ant-hill. Everywhere those who were thus rudely awakened from their old comfort and repose had swarmed forth angry and confused. Reviews, sermons, books light and heavy, came flying at the new thinker from all sides.

The keynote was struck at once in the Quarterly Review by Wilberforce, Bishop of Oxford. He declared that Darwin was guilty of "a tendency to limit God's glory in creation"; that "the principle of natural selection is absolutely incompatible with the word of God"; that it "contradicts the revealed relations of creation to its Creator"; that it is "inconsistent with the fullness of his glory"; that it is "a dishonoring view of Nature"; and the bishop ended by pointing Darwin's attention to "a simpler explanation of the presence of these strange forms among the works of God," that cause being—"the fall of Adam." Nor did the bishop's services end here; at the meeting of the British Association for the Advancement of Science he again disported himself in the tide of popular applause. Referring to the ideas of Darwin, who was absent on account of illness, the bishop in a public speech congratulated himself that he was not descended from a monkey. The reply came from Huxley, who said in substance: "If I had to choose, I would prefer to be a descendant of

a humble monkey rather than of a man who employs his knowledge and eloquence in misrepresenting those who are wearing out their lives in the search for truth."

This shot reverberated through England, and indeed through other countries.

The utterances of the most brilliant prelate of the Anglican Church received a sort of antiphonal response from the leaders of the English Catholics. In an address before the Academia, which had been organized to combat "science falsely so called," Cardinal Manning declared his "abhorrence" of the new view of Nature, and described it as "a brutal philosophy—to wit, there is no God, and the ape is our Adam."

These attacks from such eminent sources set the clerical fashion which prevailed for several years. One eminent clerical reviewer, in spite of Darwin's thirty years of quiet labor, and in spite of the powerful summing up of his book, prefaced a diatribe by saying that Darwin "might have been more modest had he given some slight reason for dissenting from the views generally entertained." Another distinguished clergyman, vice-president of a Protestant institute to combat "dangerous" science, declared Darwinism "an attempt to dethrone God." Another critic spoke of persons accepting the Darwinian views as "under the frenzied inspiration of the inhaler of mephitic gas," and of Darwin's argument as "a jungle of fanciful assumption." Another spoke of Darwin's views as suggesting that "God is dead," and declared that Darwin's work "does open violence to everything which the Creator himself has told us in the Scriptures of the methods and results of his work." Still another theological authority declares: "If the Darwinian theory is true, Genesis is a lie, the whole framework of the book of life falls to pieces, and the revelation of God to man, as we Christians know it, is a delusion and a snare." Another, who had shown excellent qualities as an observing naturalist, declared the Darwinian view "a huge imposture from the beginning."

Echoes came from America. One review, the organ of the most widespread of American religious sects, declared that Darwin "was attempting to befog and to pettifog the whole question"; another declared Darwin's views "the only form of infidelity from which Christianity had anything to fear"; another, representing the American branch of the Anglican Church, poured contempt over Darwin as "sophistical and illogical," and then plunged into an exceedingly dangerous line of argument in the following words: "If this hypothesis be true, then is the Bible an unbearable fiction; . . . then have Christians for nearly two thousand years been duped by a monstrous lie. . . . Darwin requires us to disbelieve the authoritative word of the Creator." A lead-

ing journal representing the same church took pains to show the evolution theory to be as contrary to the explicit declarations of the New Testament as to those of the Old, and said: "If we have all, men and monkeys, oysters and eagles, developed from an original germ, then is St. Paul's grand deliverance—'All flesh is not the same flesh; there is one kind of flesh of men, another of beasts, another of fishes, and another of birds'—untrue."

Another echo came from Australia, where Dr. Perry, Lord Bishop of Melbourne, in a most bitter book on Science and the Bible, declared that the obvious object of Chambers, Darwin, and Huxley is "to produce in their readers a disbelief of the Bible."

Nor was the older branch of the Church to be left behind in this chorus. Bayma, in the Catholic World, declared, "Mr. Darwin is, we have reason to believe, the mouthpiece or chief trumpeter of that infidel clique whose well-known object is to do away with all idea of a God."

Worthy of especial note as showing the determination of the theological side at this period is the foundation of sacro-scientific organizations to combat the new ideas. First to be noted is the Academia, planned by Cardinal Wiseman. In a circular letter the cardinal sounded an alarm and summed up by saying, "Now it is for the Church, which alone possesses divine certainty and divine discernment, to place itself at once in the front of a movement which threatens even the fragmentary remains of Christian belief in England." The necessary permission was obtained from Rome, the Academia was founded, and the "divine discernment" of the Church was seen in the utterances which came from it, such as those of Cardinal Manning, which every thoughtful Catholic would now desire to recall, and in the violent diatribes of Dr. Laing, which only aroused laughter on all sides. A similar effort was seen on the Protestant side; the Victoria Institute was created, and perhaps the most noted utterance which ever came from it was the declaration of its vice-president, the Rev. Walter Mitchell, that "Darwinism endeavors to dethrone God."*

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* For Wilberforce's article, see Quarterly Review, July, 1860. For the reply of Huxley to the bishop's speech I have relied on the account given in Quatrefages, who had it from Carpenter; a somewhat different version is given in the Life and Letters of Darwin. For Cardinal Manning's attack, see Essays on Religion and Literature, London, 1865. For the review articles, see the Quarterly already cited, and that for July, 1874; also the North British Review, May, 1860; also, F. O. Morris's letter in the Record, reprinted at Glasgow, 1870; also the Addresses of Rev. Walter Mitchell before the Victoria Institute, London, 1867; also Rev. B. G. Johns, Moses not Darwin, a Sermon, March 31, 1871. For the earlier American attacks, see Methodist Quarterly Review, April, 1871; the American Church Review, July and October, 1865, and January, 1866. For the Australian attack, see Science and the Bible, by the Right Reverend Charles Perry, D. D., Bishop of Melbourne, London,

In France the attack was even more violent. Fabre d'Envieu brought out the heavy artillery of theology, and in a long series of elaborate propositions demonstrated that any other doctrine than that of the fixity and persistence of species is absolutely contrary to Scripture. The Abbé Désorges, a former Professor of Theology, stigmatized Darwin as a "pedant," and evolution as "gloomy"; Monseigneur Ségur, referring to Darwin and his followers, declared: "These infamous doctrines have for their only support the most abject passions. Their father is pride, their mother impurity, their offspring revolutions. They come from hell and return thither, taking with them the gross creatures who blush not to proclaim and accept them."

In Germany the attack, if less declamatory, was no less severe. Catholic theologians vied with Protestants in bitterness. Prof. Michelis declared Darwin's theory "a caricature of creation." Dr. Hagermann asserted that it "turned the Creator out of doors." Dr. Schund insisted that "every idea of the Holy Scriptures, from the first to the last page, stands in diametrical opposition to the Darwinian theory"; and, "if Darwin be right in his view of the development of man out of a brutal condition, then the Bible teaching in regard to man is utterly annihilated." Rougemont at Stuttgart called for a crusade against the obnoxious doctrine. Luthardt, Professor of Theology at Leipsic, declared: "The idea of creation belongs to religion and not to natural science; the whole superstructure of personal religion is built upon the doctrine of creation"; and he showed that the evolution theory is in direct contradiction to Holy Writ.

But in 1863 came an event which brought serious confusion to the theological camp: Sir Charles Lyell, the most eminent of living geologists, a man of deeply Christian feeling and of exceedingly cautious and conservative temper, who had opposed the evolution theory of Lamarck and declared his adherence to the idea of successive creations, then published his work on the Antiquity of Man, and in this and other utterances showed himself a complete though unwilling convert to the fundamental ideas of Darwin. The blow was serious in many ways, and especially so in two—first, as withdrawing all foundation in fact from the scriptural chronology, and secondly, as discrediting the creation theory. The blow was not indeed unexpected; in various review articles against the Darwinian theory there had been appeals to Lyell, at times almost piteous, "not to flinch from the truths he had formerly proclaimed."

1869. For Bayma, see the Catholic World, xxvi, 782. For the Academia, see Essays edited by Cardinal Manning, above cited; and for the Victoria Institute, see Scientia Scientiarum, by a member of the Victoria Institute, London, 1865.

But Lyell, like the honest man he was, yielded unreservedly to the mass of new proofs arrayed on the side of evolution as against that of creation.

At the same time came Huxley's Man's Place in Nature, giving new and most cogent arguments in favor of evolution by natural selection.

In 1871 was published Darwin's Descent of Man. Its doctrine had indeed been anticipated by critics of his previous books, but it none the less gave a great stir to the opposite side; again the opposing army trooped forth, though evidently with much less heart than before. A few were very violent. In the Dublin University Magazine Mr. Darwin was charged, after the legendary Hibernian fashion, with seeking "to displace God by the unerring action of vagary," and as being "resolved to hunt God out of the world." But most notable from this side of the older Church was the elaborate answer to Darwin's book by the eminent French Catholic physician, Dr. Constantin James. In his work, On Darwinism, or the Man-Ape, published at Paris in 1877, Dr. James not only refuted Darwin scientifically but poured contempt on his book, calling it "a fairy tale," and hesitating to take it seriously, since a work "so fantastic and so burlesque" was, doubtless, only a huge joke, like Erasmus's Praise of Folly, or Montesquieu's Persian Letters. The princes of the Church were delighted. The Cardinal Archbishop of Paris assured the author that the book had become his "spiritual reading," and begged him to send a copy to the Pope himself. His Holiness, Pope Pius IX, acknowledged the gift in a remarkable letter. He thanked his dear son, the writer, for the book in which he "refutes so well the aberrations of Darwinism. . . . A system," he adds, "which is repugnant at once to history, to the tradition of all peoples, to exact science, to observed facts, and even to Reason herself, would seem to need no refutation, did not alienation from God and the leaning toward materialism, due to depravity, eagerly seek a support in all this tissue of fables. . . . And, in fact, pride, after rejecting the Creator of all things and proclaiming man independent, wishing him to be his own king, his own priest, and his own God—pride goes so far as to degrade man himself to the level of the unreasoning brutes, perhaps even of lifeless matter, thus unconsciously confirming the Divine declaration, *When pride cometh, then cometh shame.* But the corruption of this age, the machinations of the perverse, the danger of the simple, demand that such fancies, altogether absurd though they are, should—since they borrow the mask of science—be refuted by true science." Wherefore the Pope thanks Dr. James for his book, "so opportune and so perfectly appropriate to the exigencies of our time," and bestows on him the apostolic benediction. Nor was

this brief all. With it there came a second, creating the author an officer of the Papal Order of St. Sylvester. The Cardinal Archbishop assured the astonished physician that such a double honor of brief and brevet was perhaps unprecedented, and suggested only that in a new edition of his book he should "insist still a little more on the relation existing between the narratives of Genesis and the discoveries of modern science, in such fashion as to convince the most incredulous of their perfect agreement." The prelate urged also a more dignified title. The proofs of this new edition were accordingly all submitted to his Eminence, and in 1882 it appeared as Moses and Darwin: the Man of Genesis compared with the Man-Ape, or Religious Education opposed to Atheistic. No wonder the cardinal embraced the author, thanking him in the name of science and religion. "We have at last," he declared, "a handbook which we can safely put into the hands of youth."

Scarcely less vigorous were the champions of English Protestant orthodoxy. In an address at Liverpool, Mr. Gladstone remarked: "Upon the grounds of what is termed evolution God is relieved of the labor of creation; in the name of unchangeable laws he is discharged from governing the world"; and, when Herbert Spencer called his attention to the fact that Newton with the doctrine of gravitation and with the science of physical astronomy is open to the same charge, Mr. Gladstone retreated in the Contemporary Review under one of his characteristic clouds of words. The Rev. Dr. Coles, in the British and Foreign Evangelical Review, declared that the God of evolution is not the Christian's God. Bangor, Dean of Chichester, in a sermon preached before the University of Oxford, pathetically warned the students that "those who refuse to accept the history of the creation of our first parents according to its obvious literal intention, and are for substituting the modern dream of evolution in its place, cause the entire scheme of man's salvation to collapse." Dr. Pusey also came into the fray with most earnest appeals against the new doctrine, and the Rev. Gavin Carlyle was most earnest on the same side. The Society for Promoting Christian Knowledge published a book by the Rev. Mr. Birks, in which the evolution doctrine was declared to be "flatly opposed to the fundamental doctrine of creation." Even the London Times admitted a review of Darwin's Descent of Man, in which it was spoken of as an "utterly unsupported hypothesis," full of "unsubstantiated premises, cursory investigations, and disintegrating speculations," and Darwin himself was declared "reckless and unscientific."*

* For the French theological opposition to the Darwinian theory, see Pozzy, La Terre et le Récit Biblique de la Création, 1874, especially pp. 353, 363; also, Félix Ducane,

But it was noted that this second series of attacks, on the Descent of Man, differed in one remarkable respect—so far as England was concerned—from those which had been made over ten years before on the Origin of Species. While everything was done to discredit Darwin, to pour contempt over him, and even, of all things in the world, to make him—the gentlest of mankind, only occupied with the scientific side of the problem—"a persecutor of Christianity," while his followers were represented more and more as charlatans or dupes, there began to be in the most influential quarters careful avoidance of the old argument that evolution—even by natural selection—contradicts Scripture. It began to be felt that this was dangerous ground. The defection of Lyell had, perhaps, more than anything else, started the question among theologians who had preserved some equanimity, "What if, after all, the Darwinian theory should prove to be true?" Recollections of the position in which the Roman Church found itself after the establishment of the doctrines of Copernicus and Galileo naturally came into the minds of the more thoughtful. In Germany this consideration does not seem to have occurred at quite so early a day. One eminent Lutheran clergyman at Magdeburg called on his hearers to choose between Darwin and religion; Delitszch, in his new commentary on Genesis, attempted to bring science back to recognize human sin as an important factor in creation; Prof. Heinrich Ewald, while carefully avoiding any sharp conflict between the scriptural doctrine and evolution, comforted himself by pouring contempt over Darwin and his followers; Christlieb, in his address before the Evangelical Alliance at New York, 1873, simply took the view that the

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Études sur le Transformisme, 1876, especially pp. 107 to 119. As to Fabre d'Envieu, see especially his Proposition xliii. For the Abbé Desorges, "former Professor of Philosophy and Theology," see his Erreurs Modernes, Paris, 1878, pp. 677 and 595 to 598. For Monseigneur Ségur, see his La Foi devant la Science Moderne, sixth ed., Paris, 1874, pp. 23, 34, etc. For Herbert Spencer's reply to Mr. Gladstone, see his Study of Sociology; for the passage in the Dublin Review, see the issue for July, 1871. For the review in the London Times, see Nature for April 20, 1871. For Gavin Carlyle, see The Battle of Unbelief, 1870, pp. 86 and 171. For the attacks by Michelis and Hagermann, see Natur und Offenbarung, Münster, 1861 to 1869. For Schund, see his Darwin's Hypothese und ihr Verhältniss zu Religion und Moral, Stuttgart, 1869. For Luthardt, see Fundamental Truths of Christianity, translated by Sophia Taylor, second ed., Edinburgh, 1869. For Rougemont, see his Der Mensch und der Affe, Stuttgart, 1863, translated into German. For Constantin James, see his Mes Entretiens avec l'Empéreur Don Pédro sur le Darwinisme, Paris, 1888, where the papal briefs are printed in full. For the English attacks on Darwin's Descent of Man, see the Edinburgh Review, July, 1871, and elsewhere; the Dublin Review, July, 1871; the British and Foreign Evangelical Review, April, 1886. See also The Scripture Doctrine of Creation, by the Rev. T. R. Birks, London, 1873, published by the S. P. C. K. For Dr. Pusey's attack, see his Unscience not Science, adverse to Faith, 1878; also, Darwin's Life and Letters, vol. ii, pp. 411, 412.

tendencies of the Darwinian theory were "toward infidelity," but declined to make any serious battle on biblical grounds; the Jesuit, Father Pesch, in Holland, drew up in Latin in due array, after the old scholastic manner, a sort of general indictment of evolution, of which one must say that it was interesting—as interesting as the display of a troop in chain armor and with crossbows on a nineteenth-century battlefield.

From America there came new echoes. Among the myriad attacks on the Darwinian theory by Catholics and Protestants two should be especially mentioned. The first of these was by Dr. Noah Porter, President of Yale College, an excellent scholar, an interesting writer, a noble man, broadly tolerant, combining in his thinking a curious mixture of radicalism and conservatism. While giving great latitude to the evolutionary teaching in the university under his care, he felt it his duty upon one occasion to avow his disbelief in it; but he was very careful not to suggest any necessary antagonism between it and the Scriptures. He confined himself mainly to pointing out the tendency of the evolution doctrine in this form toward agnosticism and pantheism. To those who knew and loved him and had noted the genial way in which by wise neglect he had allowed scientific studies to flourish at Yale, there was an amusing side to all this. Within a stone's throw of his college rooms was the Museum of Paleontology, in which Prof. Marsh had laid side by side, among other evidences of the new truth, that wonderful series of specimens showing the evolution of the horse from the earliest form of the animal, "not larger than a fox, with five toes," through the whole series up to his present form and size—that series which the most eminent living exponent of the Darwinian view has declared an absolute proof of the existence of natural selection as an agent in evolution. In spite of the veneration and love which all Yale men felt for President Porter, it was hardly to be expected that these particular arguments of his would have much permanent effect upon them when there was constantly before their eyes so convincing a refutation.

But a far more determined and bitter opponent was the Rev. Dr. Hodge, of Princeton; his anger toward the evolution doctrine seemed to madden him: he declared it thoroughly "atheistic"; he insisted that Christians "have a right to protest against the arraying of probabilities against the clear evidence of the Scriptures"; he even censured so orthodox a writer as the Duke of Argyll, and declared that the Darwinian theory of natural selection is "utterly inconsistent with the Scriptures," and that "an absent God, who does nothing, is to us no God"; that "to ignore design as manifested in God's creation is a theory which attempts to dethrone God"; that "a denial of design in Nature is virtually

a denial of God"; and that "no teleologist can be a Darwinian." Even more bitter was another of the leading authorities at the same university—the Rev. Dr. Duffield. He declared war not only against Darwin but even against men like Asa Gray, Le Conte, and others, who had attempted to reconcile the new theory with the Bible; he insisted that "evolutionism and the scriptural account of the origin of man are irreconcilable"—that the Darwinian theory is "in direct conflict with the teaching of the apostle, 'All scripture is given by inspiration of God'"; he points out, in opposition both to Darwin's Descent of Man and Lyell's Antiquity of Man, that in the Bible "the genealogical links which connect the Israelites in Egypt with Adam and Eve in Eden are explicitly given." These utterances of Prof. Duffield culminated in a declaration which deserves to be cited as showing that a Presbyterian minister can "deal damnation round the land" *ex cathedra* in a fashion quite equal to that of popes and bishops. It is as follows: "If the development theory of the origin of man," wrote Dr. Duffield in the Princeton Review, "shall in a little while take its place—as doubtless it will—with other exploded scientific speculations, then they who accept it with its proper logical consequences will in the life to come have their portion with those who in this life 'know not God and obey not the gospel of his Son.'"

Fortunately, at about the time when Darwin's Descent of Man was published, there had come into Princeton University a "*deus ex machina*" in the person of Dr. James McCosh. Assuming the presidency, he at once took his stand against teachings so dangerous to Christianity as those of Drs. Hodge, Duffield, and their *confrères*. In one of his personal confidences he has let us into the secret of this matter. With that hard Scotch sense which had won the applause of Thackeray in his well-known verses, he saw that the most dangerous thing which could be done to Christianity at Princeton was to reiterate in the university pulpit, week after week, solemn declarations that if evolution by natural selection, or indeed evolution at all, be true, the Scriptures are false. McCosh tells us that he saw that this was the certain way to make the students unbelievers; he therefore not only gave a check to this dangerous preaching but preached an opposite doctrine. With him began the inevitable compromise, and, in spite of mutterings against him as a Darwinian, he carried the day. Whatever may be thought of the general system of philosophy which he has advocated, no one can deny the great service he rendered in neutralizing the teachings of his predecessors and colleagues—so dangerous to all that is essential in Christianity.

Other divines of strong sense in other parts of the country began to take similar ground—namely, that men could be Christians

and at the same time believe in the Darwinian theory. There appeared, indeed, here and there, curious discrepancies; thus in 1873 the Monthly Religious Magazine of Boston congratulated its readers that the Rev. Mr. Burr had "demolished the evolution theory, knocking the breath of life out of it and throwing it to the dogs." This amazing performance by "the Rev. Mr. Burr" was repeated in a different form and in a very striking way by Bishop Keener before the Œcumenical Council of Methodism at Washington in 1891. In what is described in the newspapers as an "admirable speech," he refuted evolution doctrines by saying that evolutionists had only to make a journey of twelve hours from the place in which he was then standing and find together the bones of the muskrat, the opossum, the coprolite, and the ichthyosaurus. He asserted that Agassiz—whom the good bishop, like so many others, seemed to think an evolutionist—when he visited these beds near Charleston, declared: "These old beds have set me crazy; they have destroyed the work of a lifetime"; and the Methodist prelate ended by saying: "Now, gentlemen, brethren, take these facts home with you; get down and look at them. This is the watch that was under the steam hammer—the doctrine of evolution; and this steam hammer is the wonderful deposit of the Ashley beds."

Exhibitions like these availed little. While the good bishop amid vociferous applause thus made comically evident his belief that Agassiz was a Darwinian and a coprolite an animal, scientific men were recording in all parts of the world facts confirming the dreaded theory of an evolution by natural selection. While the Rev. Mr. Burr was so loudly praised for "chopping up Darwinism and throwing it to the dogs," Marsh was completing his series leading from the five-toed ungulates to the horse; while Dr. Tayler Lewis at Union, and Drs. Hodge and Duffield at Princeton, were showing that if evolution is true the biblical accounts are false, the indefatigable Yale professor was showing his cretaceous birds, and among them *Hesperornis* and *Ichthyornis* with teeth; while in Germany Luthardt, Schund, and their compeers were demonstrating that Scripture requires a belief in special and separate creations, the *Archæopteryx*, showing a most remarkable connection between birds and reptiles, was discovered; while in France Monseigneur Ségur and others were indulging in diatribes against "a certain Darwin," Gaudry and Filhol were discovering a striking series of "missing links" among the carnivora.

In view of the proofs accumulating in favor of the new evolutionary hypothesis, the change in the tone of controlling theologians was now rapid. From all sides came evidences of desire to compromise with the theory. The strict adherents of the biblical text pointed significantly to the texts in Genesis in which the

earth and sea were made to bring forth birds and fishes, and man was created out of the dust of the ground. Men of broader mind like Kingsley and Farrar, and English and American broad churchmen generally, took ground directly in Darwin's favor. Even Whewell took pains to show that there might be such a thing as a Darwinian argument for design in Nature; and the Rev. Samuel Houghton, of the Royal Society, gave interesting suggestions of a teleological evolution.

Both the great English universities received the new teaching as a leaven; at Oxford, in the very front of the High Church party at Keble College, was elaborated a statement that the evolution doctrine is "an advance in our theological thinking"; and Temple, Bishop of London, perhaps the most influential thinker at present in the Anglican episcopate, accepted the new revelation in the following words: "It seems something more majestic, more befitting Him to whom a thousand years are as one day, thus to impress his will once for all on his creation, and provide for all the countless varieties by this one original impress, than by special acts of creation to be perpetually modifying what he had previously made."

In Scotland the Duke of Argyll, head and front of the orthodox party, dissenting in many respects from Darwin's full conclusions, made concessions which disorganized the old position.

Curiously enough, from the Roman Catholic Church, bitter as some of its writers had been, now came argument to prove that the Catholic faith does not prevent any one "from holding the Darwinian theory," and especially a declaration from an authority eminent among American Catholics—a declaration which has a very curious sound, but which it would be ungracious to find fault with—that "the doctrine of evolution is no more in opposition to the doctrine of the Catholic Church than is the Copernican theory or that of Galileo."

Here and there, indeed, men of science like Dawson, Mivart, and Wigand, in view of theological considerations, have sought to make conditions; but the current is too strong, and we find eminent theologians in every country ready to accept natural selection as at least a very important part in the mechanism of evolution.

At the death of Darwin it was felt that there was but one place in England where his body should be laid, and that this place was next the grave of Sir Isaac Newton in Westminster Abbey. The noble address of Canon Farrar at his funeral was echoed from many pulpits in Europe and America, and theological opposition as such was ended. Occasionally there came, it is true, a survival of the old feeling; the Rev. Dr. Laing referred to the burial of Darwin in Westminster Abbey as "a proof that Eng-

land is no longer a Christian country," and added that this burial was a desecration—that this honor was given him because he had been "the chief promoter of the mock doctrine of evolution of the species and ape descent of man"; and this was echoed in Scotland by the Rev. Dr. Lee, who was pleased to call Darwin and his followers "gospelers of the gutter."

Still another of these belated prophets was, of all men, Thomas Carlyle. Soured and embittered, in the same spirit which led him to find more heroism in a marauding Viking or in one of Frederick the Great's generals than in Washington, or Lincoln, or Grant, and which caused him to see in the American civil war only "the burning out of a foul chimney," he simply saw in Darwin an "apostle of dirt worship."

The last echoes of this sort of utterance reverberated between Scotland and America. In the former country, in 1885, the Rev. Dr. Lee issued a volume in which it was declared that, if the Darwinian view be true, "there is no place for God"; that "by no method of interpretation can the language of Holy Scripture be made wide enough to re-echo the orang-outang theory of man's natural history"; that "Darwinism reverses the revelation of God" and "implies utter blasphemy against the divine and human character of our Incarnate Lord." In one of the intellectual centers of America the editor of a periodical called The Christian urged frantically that "the battle be set in array, and that men find out who is on the Lord's side and who is on the side of the Devil and the monkeys."

To the honor of the Church of England it should be recorded that a considerable number of its truest men opposed such utterances as these, and that one of them—Farrar, Archdeacon of Westminster—made a protest worthy to be held in perpetual remembrance. While confessing his own inability to accept fully the new scientific belief, he said: "We should consider it disgraceful and humiliating to try to shake it by an *ad captandum* argument, or by a claptrap platform appeal to the unfathomable ignorance and unlimited arrogance of a prejudiced assembly. We should blush to meet it with an anathema or a sneer."

All opposition had availed nothing; Darwin's work and fame were secure. As men looked back over his beautiful life—simple, honest, tolerant, kindly—and thought upon the great truth he had given to mankind, all the attacks faded into nothingness.

There were indeed some dark spots, which as time goes on appear darker. At Trinity College, Cambridge, Whewell, the "omniscient," author of the History of the Inductive Sciences, refused to allow a copy of the Origin of Species to be placed in the library. At multitudes of institutions under theological control—Catholic as well as Protestant—attempts were made to

stamp out or to stifle evolutionary teaching. Especially was this true for a time in America, and the case of the American College at Beyrout, where nearly all the younger professors were dismissed for adhering to Darwin's views, is worthy of remembrance. The treatment of Dr. Winchell at the Vanderbilt University in Tennessee showed the same spirit; one of the truest of men, devoted to science but of deeply Christian feeling, he was driven forth for views which centered in the Darwinian theory.

Still more striking was the case of Dr. Woodrow. He had, about 1857, been appointed to a professorship of Natural Science as connected with Revealed Religion, in the Presbyterian Seminary at Columbia, South Carolina. He was a devoted Christian man, and his training had led him to accept the Presbyterian standards of faith. With great gifts for scientific study he visited Europe, made a most conscientious examination of the main questions under discussion, and adopted the chief points in the doctrine of evolution by natural selection. A struggle soon began. A movement hostile to him grew more and more determined, and at last, in spite of the efforts made in his behalf by the directors of the seminary and by a large and broad-minded minority in the representative bodies controlling it, an orthodox storm, raised by the delegates from various Presbyterian bodies, drove him from his post. Fortunately, he was received into a professorship at the University of South Carolina, where he has since taught with more power than ever before.

This testimony to the faith by American provincial Protestantism was very properly echoed from Spanish provincial Catholicism. In the year 1878 a Spanish colonial man of science, Dr. Chil y Marango, published a work on the Canary Islands. But Dr. Chil had the imprudence to sketch, in his introduction, the modern hypothesis of evolution, and to exhibit some proofs, found in the Canary Islands, of the barbarism of primitive man. The ecclesiastical authorities, under the lead of Bishop Urquinaona y Bidot, at once grappled with this new idea. By a solemn act they declared it "*falsa, impia, scandalosa*"; all persons possessing copies of the work were ordered to surrender them at once to the proper ecclesiastics, and the author was placed under the major excommunication, which, in those "fortunate isles," still means social isolation.

But all this opposition may be reckoned among the last expiring convulsions of the old theologic theory. Even from the new Catholic University at Washington has come an utterance in favor of the new doctrine, and in other universities in the Old World and in the New the doctrine of evolution by natural selection has asserted its right to full and honest consideration. More than this, it is clearly evident that the stronger men in the

Church have, in these latter days, not only relinquished the struggle against science in this field, but have determined frankly and manfully to make an alliance with it. In two very remarkable lectures given in 1892 at the parish church of Rochdale, Wilson, Archdeacon of Manchester, not only accepts Darwinism as true, but works it with great argumentative power into a higher view of Christianity; and what is of great significance, these sermons were published by the same Society for the Propagation of Christian Knowledge which only a few years previously had published the most bitter attacks against the Darwinian theory. So, too, during the year 1893, Prof. Henry Drummond, whose praise is in all the dissenting churches, developed a similar view most brilliantly in a series of lectures delivered before the American Chautauqua Schools, and published in one of the most widespread of English orthodox newspapers.

Whatever additional factors may be added to natural selection—and Darwin himself fully admitted that there might be others—the theory of an evolution process in the formation of the universe and of animated Nature is established, and the old theory of direct creation is gone forever. In place of it science has given us conceptions far more noble, and opened the way to an argument for design infinitely more beautiful than any ever developed by theology.*

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* For reasons of the bitterness shown regarding the Darwinian hypothesis, see Reusch, Bibel und Natur, vol. ii, pp. 46 *et seq.* For hostility in the United States toward the Darwinian theory, see among a multitude of writers the following: Dr. Charles Hodge, of Princeton, monograph, What is Darwinism? New York, 1874; also his Systematic Theology, New York, 1872, vol. ii, part 2, Anthropology. For a laudatory notice of the Rev. E. F. Burr's demolition of evolution in his book Pater Mundi, see Monthly Religious Magazine, Boston, May, 1873, p. 492; also The Light by which we see Light, or Nature and the Scriptures, Vedder Lectures, 1875, Rutgers College, New York, 1875; also Positivism and Evolutionism, in the American Catholic Quarterly, October, 1877, pp. 607, 619; and in the same number, Professor Huxley and Evolution, by Rev. A. M. Kirsch, pp. 662, 664; The Logic of Evolution, by Prof. Edward F. X. McSweeney, D. D., July, 1879, p. 561; Das Hexaemeron und die Geologie, von P. Eirich, Pastor in Albany, N. Y., Lutherischer Concordia-Verlag, St. Louis, Mo., 1878, pp. 81, 82, 84, 92–94; Evolutionism respecting Man and the Bible, by John T. Duffield, of Princeton, January, 1878, Princeton Review, pp. 151, 153, 154, 158, 159, 160, 188; A Lecture on Evolution, before the Nineteenth Century Club of New York, May 25, 1886, by ex-President Noah Porter, pp. 4, 26–29; Evolution or Not, extract in the New York Weekly Sun, October 24, 1888, concerning the removal of Rev. Dr. James Woodrow, Professor of Natural Science in the Columbia Theological Seminary. For the dealings of Spanish ecclesiastics with Dr. Chil and his Darwinian exposition, see the Revue d'Anthropologie, cited in the Academy for April 6, 1878; see also the Catholic World, xix, 433, A Discussion with an Infidel, directed against Dr. Louis Büchner and his Kraft und Stoff; also in Mind and Matter, by Rev. James Tait, of Canada, p. 66; in the third edition the author bemoans the "horrible plaudits" that "have accompanied every effort to establish man's brutal descent"; also The Church Journal, New York, May 28, 1874. For the effort in favor of a theological evolution, see Rev. Samuel Houghton, F. R. S.,

Principles of Animal Mechanics, London, 1873, preface and p. 156 and elsewhere. For details of the persecution of Drs. Winchell and Woodrow, and of the Beyrout professors, with authorities cited, see my chapter on The Fall of Man and Anthropology. For more liberal views among various religionists regarding the Darwinian theory, and for efforts to mitigate and adopt it to theological views, among the great mass of utterances see the following: Charles Kingsley, Letters to Darwin, November 18, 1859, in Darwin's Life and Letters, vol. ii, p. 82; Adam Sedgwick to Charles Darwin, December 24, 1859, see ibid., vol. ii, pp. 356–359; the same to Miss Gerard, January 2, 1860, see Sedgwick's Life and Letters, vol. ii, pp. 359, 360; the same in the Spectator, London, March 24, 1860; The Rambler, March, 1860, cited by Mivart, Genesis of Species, p. 30; The Dublin Review, May, 1860. For a review of the Origin of Species, The Christian Examiner, Boston, May, 1860, on the Origin of Species; Charles Kingsley to F. D. Maurice in 1863, see Kingsley's Life, vol. ii, p. 171; Adam Sedgwick to Livingstone (the explorer), March 16, 1865; see Life and Letters of Sedgwick, vol. ii, pp. 410–412; The Duke of Argyll, The Reign of Law, New York, pp. 16, 18, 31, 116, 117, 120, 159; Joseph P. Thompson, D. D., LL. D., Man in Genesis and Geology, New York, 1870, pp. 48, 49, 82; James Freeman Clarke, a review in the Old and New Magazine, Boston, September, 1870, on his Steps of Belief; Canon H. P. Liddon, Sermons preached before the University of Oxford, 1871, Sermon III; St. George Mivart, Evolution and its Consequences, Contemporary Review, January, 1872; British and Foreign Evangelical Review, vol. xxi, p. 18, 1872, article on The Theory of Evolution; also pp. 2, 22, 8, 9, 15; The Lutheran Quarterly, Gettysburg, Pa., April, 1872, article by Rev. Cyrus Thomas, Assistant United States Geological Survey, on The Descent of Man, pp. 214, 239, 372–376; The Lutheran Quarterly, July, 1873, article, Some Assumptions against Christianity, by Rev. C. A. Stork, Baltimore, Md., pp. 325, 326; also in same number, see a review of Dr. Burr's Pater Mundi, pp. 474, 475, and contrast with the review in the Andover Review of that period; an article in the Religious Magazine and Monthly Review, Boston, on Religion and Evolution, by Rev. S. R. Calthrop, September, 1873, p. 200; The Popular Science Monthly, January, 1874, article Genesis, Geology, and Evolution, by Rev. George Henslow—this article first appeared in his book Evolution and Religion; article by Asa Gray, Nature, London, June 4, 1874; Materialism, by Rev. W. Streissguth, Lutheran Quarterly, July, 1875, originally written in German, and translated by J. G. Morris, D. D., pp. 406, 408; Darwinismus und Christenthum, von R. Steck, Ref. Pfarrer in Dresden, Berlin, 1875, pp. 5, 6, and 26, reprinted from the Protestantische Kirchenzeitung, and issued as a tract by the Protestantenverein; Oscar Peschel, Abhandlungen zur Erd- und Völkerkunde, Leipsic, 1877, pp. 503, 504—this article first appeared in Ausland, for January 2, 1869 (Peschel was editor of this weekly magazine); Rev. W. E. Adams, article in the Lutheran Quarterly, April, 1879, on Evolution: shall it be Atheistic? John Wood, Bible Anticipations of Modern Science, 1880, pp. 18, 19, 22; Lutheran Quarterly, January, 1881, Some Postulates of the New Ethics, by Rev. C. A. Stork, D. D.; Lutheran Quarterly, January, 1882, The Religion of Evolution as against the Religion of Jesus, Prof. W. H. Wynn, Iowa State Agricultural College—this article was republished as a pamphlet; Canon Liddon, prefatory note to sermon on the Recovery of St. Thomas, pp. 4, 11, 12, 13, and 26, preached in St. Paul's Cathedral, April 23, 1882; Lutheran Quarterly, January, 1882, Evolution and the Scripture, by Rev. John A. Earnest, pp. 101, 105; Glimpses in the Twilight, by Rev. F. G. Lee, D. D., Edinburgh, 1885, especially pp. 18 and 19; the Hibbert Lectures for 1883, by Rev. Charles Beard, pp. 392, 393 *et seq.*; F. W. Farrar, D. D., Canon of Westminster, The History of Interpretation, being the Barrington Lectures for 1885, pp. 426, 427; Bishop Temple, Barrington Lectures, pp. 184–186; article Evolution, in the Dictionary of Religion, edited by Rev. William Benham, 1887; Prof. Huxley, An Episcopal Trilogy, Nineteenth Century, November, 1887—this article discusses three sermons delivered by the Bishops of Carlisle, Bedford, and Manchester, in Manchester Cathedral, during the meeting of the British Association, September, 1887; these sermons were afterward published in pamphlet form under the title, The Advance of Science; John Fiske, Darwinism, and other Essays, Boston, 1888; Harriet Mackenzie, Evolution illuminating the Bible, Lon-

NICARAGUA AND THE MOSQUITO COAST.

By ROBERT N. KEELY, Jr., M. D.

EVERY once in a while something happens to rouse Americans out of that complaisant frame of mind which has become habitual, and in which they have come to regard their imperial domain, bounded by the Great Lakes and the Rio Grande to the North and South, and the broad ocean to the East and West, as a sort of little world all to themselves, whence they could look out upon the doings beyond with a patronizing half-humorous indifference, as upon things in which they had no possible concern. A few months ago the shock was supplied by the unheralded supplication from a small island nation out in the Pacific to be taken under the broad wing of the "bird of freedom," and we awoke to the fact that perhaps in spite of ourselves and our national prejudices the logic of events had extended our zone of political influence far beyond our supposed definitive boundaries. Now comes Nicaragua, her warring factions having concluded an armistice, and asks Uncle Sam to arbitrate, with suggestions even of the advisability of an American protectorate; and it is quite possible that upon a little reflection we may discover that this fussy little republic is as essentially an integral portion of the United States of the future as if it lay between Chicago and Denver. Possessing the most practicable water way over the isthmus which divides New York from San Francisco, it may well be that the increasing necessity of a purely American ocean highway between these two ports must soon render inevitable a political predominance on our part which shall amount to virtual sovereignty over these regions.

But for a trifling incident it would never have occurred to me to go to Nicaragua. Excepting as an eligible site for a canal and

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don, 1891, dedicated to Prof. Huxley; H. E. Ryle, Hulsean Professor of Divinity at Cambridge, The Early Narratives of Genesis, London, 1892, preface, pp. vii–ix, pp. 7, 9, 11; Rev. G. M. Searle, of the Catholic University, Washington, article in the Catholic World, November, 1892, pp. 223, 227, 229, 231. For the statement from Keble College, see Rev. Mr. Illingworth, in Lux Mundi. For Bishop Temple, see citation in Laing. For the most complete and admirable acceptance of the evolution theory as lifting Christian doctrine and practice to a higher plane, with suggestions for a new theology, see two sermons by Archdeacon Wilson, of Manchester, S. P. C. K., London, and Young & Co., New York, 1893; and for a characteristically lucid statement of the most recent development of evolution doctrines, and the relations of Spencer, Weissmann, Galton, and others to them, see Lester F. Ward's Address as President of the Biological Society, Washington, 1891; also, recent articles in the leading English reviews. For a brilliant glorification of evolution by natural selection as a doctrine necessary to the highest and truest view of Christianity, see Prof. Drummond's Chautauqua Lectures, published in The British Weekly, London, from April 20 to May 11, 1893.

FIG. 1.—BLUEFIELDS.

as the scene of Filibuster Walker's bold exploit, the country had never been associated with my thoughts, and canals and filibusters were not in my line. I had perhaps an adumbration of centipeds and scorpions and of a people in a chronic state of revolution, which surely is not an alluring mental picture. It happened, however, that I had made preparations to go with an expedition for an extended tour of the West Indies, and was all ready to depart, when at the last moment the project was indefinitely postponed. Trunks and gripsacks were neatly packed and good-byes had been duly bidden, and here I was without any destination. In this perplexity a letter was handed me bearing an unfamiliar post-mark. Hastily tearing open the envelope, I read:

"BLUEFIELDS, NICARAGUA, *April 5, 1893.*

"MY DEAR OLD BOY: You have been wondering, no doubt, not to have heard from me all these years, and your surprise will be greater to hear from me out of this strange quarter of the globe. . . . Well, my boy, I've been at work, hard at work, and, as the world would say, I've prospered. . . . I am working a very valuable grant, covering one hundred square miles. The bottoms are rich in timber and the uplands abound with gold. Native help is plentiful and can be hired for a song and sixpence, and the mahogany can be floated all the way to the coast. I want a congenial associate, and don't know any one with whom I would rather share my good fortune. At any rate, since I heard, by the rarest chance, that you were on the way to the Caribbean, you would find a run over to view the country well worth your while, etc. H."

Here was an impulse, all that was needed—so ho! and away for Nicaragua!

THE MOSQUITOS.—The 10th of May, 1893, found us aboard a little schooner from Greytown bound for Bluefields, the capital of that singular and little-known people the Mosquito Indians.

The portion of the Caribbean littoral commonly known as the Mosquito Coast, but more accurately called the "Mosquito Reservation," is a strip of land about two hundred miles in length extending northward from the Rama River to the Rio Huesco, and backward from the sea about forty miles; the western boundary being an astronomical line along the meridian of longitude 84° 15′.

The so-called Mosquito Indians are by no means a homogeneous people. The interior river districts are inhabited by true Indians of various tribes and languages, agricultural in their habits—if such a thing as agriculture can be spoken of in this land of spontaneous vegetation and perennial summer. The coast

lands, which along their whole length are indented with a series of shallow lagoons separating them from the main sea, are inhabited by a mixed race in whose veins African and Indian blood are striving for the ascendency, with a dash of white blood infused

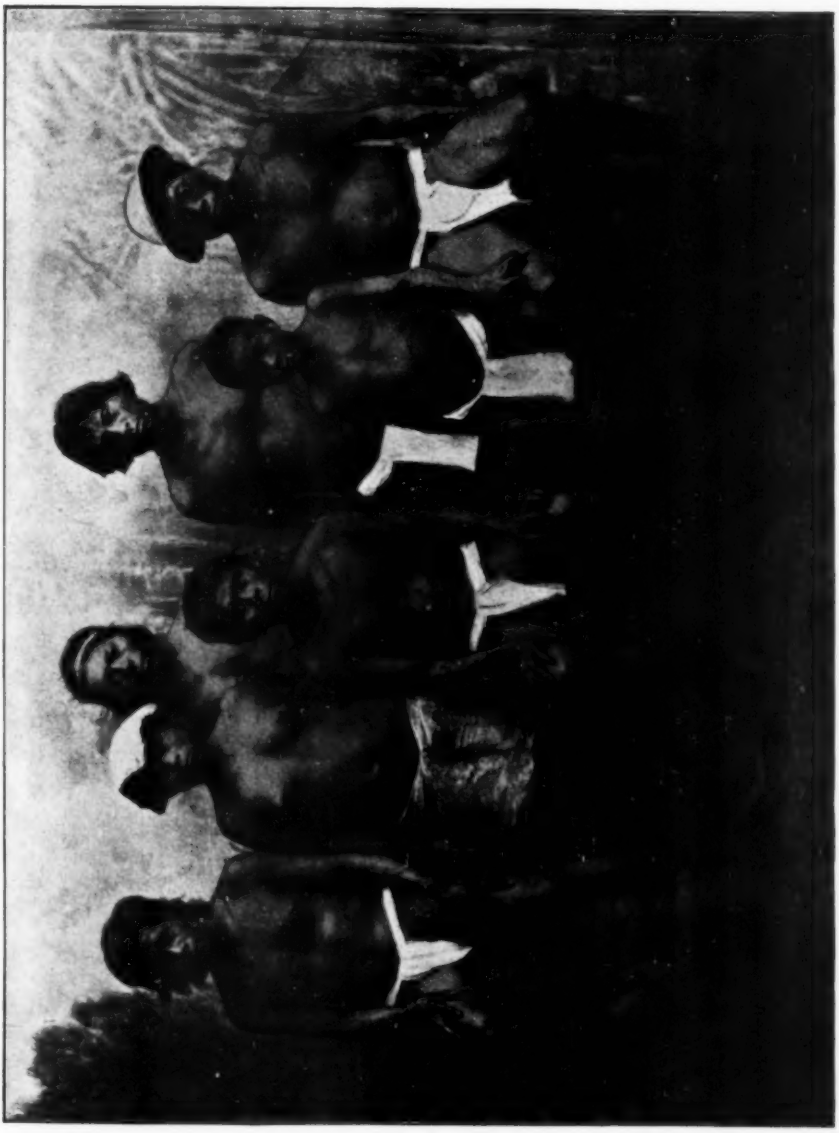

FIG. 2.—MOSQUITO INDIANS.

by buccaneers and Jamaica traders of the olden times. In the government of the community the people of the coast lands are the predominant element, the Indians farther in the interior being apathetic; nevertheless, the "chief," who is at the head of the government, is a full-blooded Indian. The official language,

and that generally spoken along the coast, is the English tongue. The Mosquito state is an autonomy under the sovereignty of Nicaragua, but to understand its unique position in the family of nations it would be necessary to give an outline of its more recent history. Such a sketch would scarcely prove of interest, and would far exceed the limits of this article.

Bluefields, the capital and only port of the Mosquito Reservation, gets its name from a famous old pirate of the past, called Bleevelt, the remains of whose stronghold—in an advanced state of decay—are still seen on a high promontory at the entrance of the harbor known as the "Bluff." The town proper lies about six miles from the sea, and is reached by crossing a large lagoon of such shallowness that only after much tugging, pushing, and pulling in small boats of the lightest draught is the passenger landed at the Government wharf. Seen from the lagoon, the town presents a pleasant picture. Seated upon comparatively high ground, the luscious green of the luxuriant vegetation in which it is framed runs quite down to the water's edge, while here and there a stately palm or cocoanut tree, its leaves nodding lazily in the almost imperceptible breeze, gives the landscape that calm, dreamy look so characteristic of tropical life. There is but one street in the town (King Street) leading up from the wharf. On this street are its few stores and trade shops. The rest of the settlement—covering an area of two square miles—is scattered about, wheresoever the householders willed it, without plan or reference to streets and lanes. At the time of my visit the town contained three horses and two carts or wagons, so it is evident that streets would be of less use for traffic than for the sake of symmetry, and Sambo idea of symmetry is an unknown quantity. The houses of Bluefields, with the exception of a few native "shacks," are built of lumber brought from the United States, and are similar in style of architecture to those found in small American villages. All buildings are erected on posts, and raised two or three feet above the ground, to avoid the wet and mud of the rainy season. The population, numbering about fifteen hundred, is composed principally of the descendants of Jamaica negroes, with a sprinkling of cross-breed Indians, Spaniards, and negroes; these are known as "Sambos."

BLUEFIELDS AND BANANAS.—Such as it is, Bluefields owes its prosperity chiefly to American enterprise and capital. The increasing demand in the States for bananas, and the proximity of the Mosquito country to New Orleans (the journey being only four days by steamer), induced some Americans of a speculative turn to explore the country, with a view to supplying the demand for the fruit. Their ventures were successful beyond expectation, the soil and climate being peculiarly adapted for banana grow-

ing, and to-day hundreds of beautiful plantations line the river banks for many miles, producing an average of forty thousand bunches per week, and Bluefields ships more of this fruit than any two other ports of the world. Among the signs of American influence is the appearance of the newspaper, a never-wanting adjunct to every well-regulated American embryo city. The paper, printed in English and issued weekly, is called the Bluefields Sentinel. It has quite a United States air about it, and is well pep-

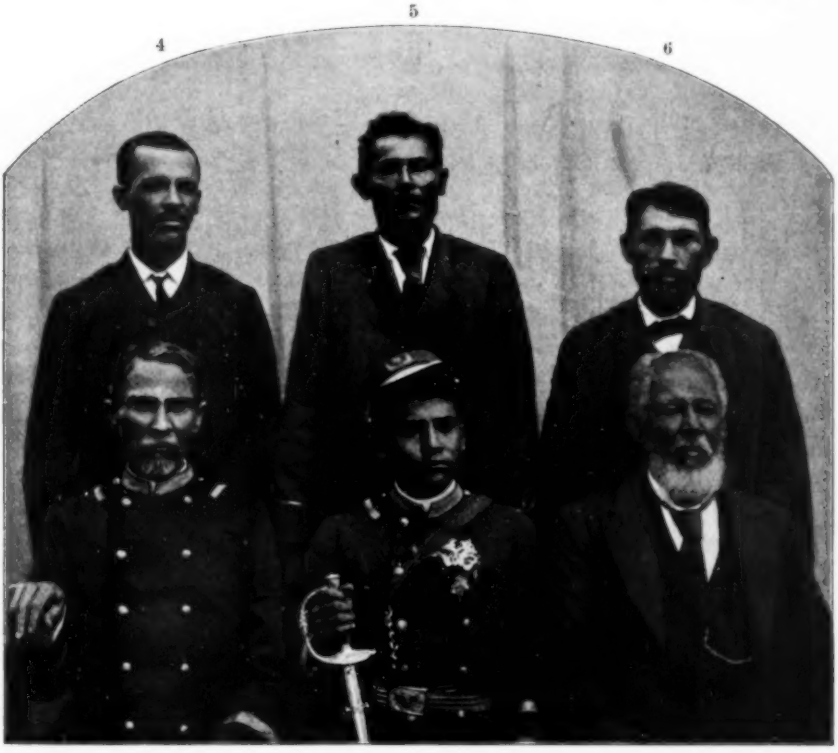

FIG. 3.—THE MOSQUITO CHIEF AND EXECUTIVE COUNCIL: 1, Robert Henry Clarence, chief; 2, Hon. Charles Patterson, vice president and guardian; 3, Hon. J. W. Cuthbert, attorney general and secretary to the chief; 4, Mr. J. W. Cuthbert, Jr., government secretary; 5, Mr. George Haymond, councilman and headman; 6, Mr. Edward McCrea, councilman and headman.

pered with advertisements. The spiritual and educational welfare of the community has been taken in hand by the "Moravian Mission," whose little churches and schools are scattered all over the territory, and on Sunday the single street of Bluefields is alive with churchgoers, who seem to be coming and going to and from religious service all day long.

The government of the Mosquito Reservation consists of the hereditary chief and an Executive Council, the members of the

Executive Council being elected by a General Council, and the latter in turn being appointed by the chief from among the "head men" of the tribe and representative inhabitants of the various districts of the country. The present chief, his Excellency Robert Henry Clarence, who, as above stated, is a full-blooded Mosquito Indian, is a handsome, intelligent, and well-educated young man of twenty or thereabouts, with a magnificent head of glossy black hair. The other government officials are nearly all descendants of Jamaica negroes, and perform their duties with becoming gravity and ease. Hon. Charles Patterson, the vice president, whose features betray some admixture of European blood, is also the guardian of the chief during his minority. The law of the land, by the Mosquito Constitution, is declared to be the common and statutory law of England, so far as the same can be made applicable and not inconsistent with local customs and the enactments of the chief and Council. Many of the young men who desire educational advantages better than the local schools afford are sent to Jamaica or even to England. The land laws are very liberal. Each head of a family is permitted to take six hundred and forty acres on a ninety-nine years' lease, for which he pays an annual rental of three cents an acre to the Government, equal to about fifteen dollars American gold. He is expected to pay, besides, the cost of surveying his "section," but beyond this there is no tax of whatever kind imposed, no matter how valuable the improvements he may make. Altogether the Mosquito people have made a considerable advance toward civilized life. The missionaries have not succeeded entirely in uprooting the superstitious practices among the lowest walks of the population, and the *obeah* or *obeaism*, a system of necromancy, by which ill luck can be averted and injuries done to your enemies, has still a powerful hold. The periodic "big drunk" of former times, when whole villages used to engage in wild orgies, is no longer a popular institution, although it is possible that individuals do not disdain to indulge in a periodic spree. The Mosquitos proudly and justly boast that for many years they have lived and maintained their institutions in peace, whereas the sovereign Republic of Nicaragua is constantly riven and torn by revolutions and strife. The state of culture described is found, however, only in the "cities" and mission stations. Away from these and in the jungles the people are still pure savages.

The chapter on roads in Mosquito is as brief and of the same tenor as the chapter on snakes in Iceland. The only means of communication are the rivers and lagoons; beyond these all is dense, impenetrable forest and jungle, interspersed here and there in the more northerly portions by grassy plains called savannas. The principal article of commerce, besides the banana, is

mahogany. This huge timber is cut by the Indians of the interior, and hauled and shoved toward a river in the immediate vicinity, thence floated in rafts of two or three logs, or often as a single tree, down to the coast. Most of the banana plantations are on the Bluefields or Escondido River. The mouth of the river is about a mile north of Bluefields, and the plantations begin about twenty miles above this point and thence cover its banks in almost unbroken continuity for some distance beyond the city of Rama, sixty miles up stream. To facilitate the handling and shipping of the fruit, the plantations are always close to the banks, and vary in depth from fifty to two thousand yards.

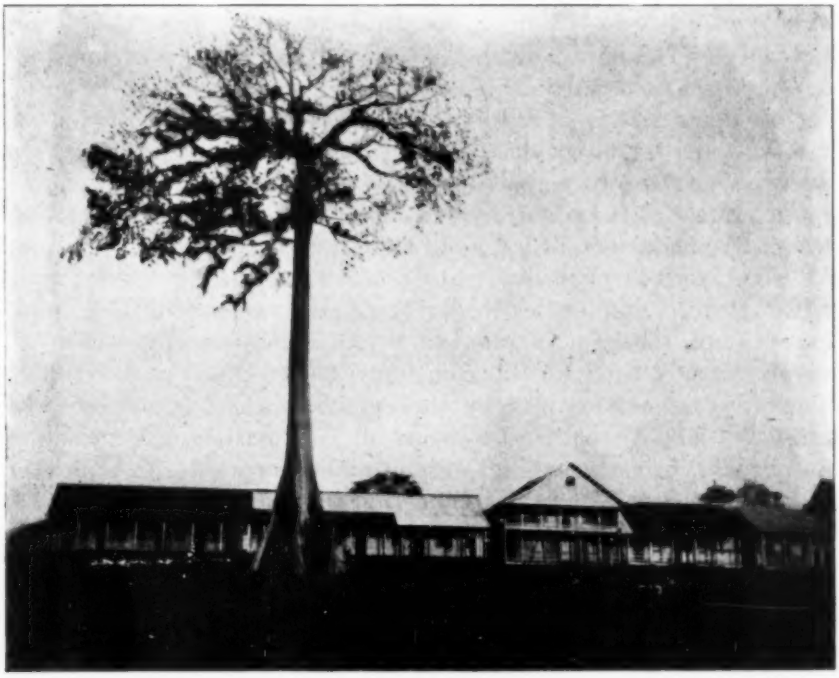

FIG. 4.—RAMA.

The steamer Hendy, an old Mississippi River boat, whose lightness of draught makes it well adapted for steaming about the shallow lagoons, plies regularly between Bluefields and Rama. Leaving the former place at seven o'clock in the morning, the trip to Rama begins by rounding a point of land called "Old Bank," a place which for a short time was the home of a small German colony. This settlement was abandoned after repeated trials and disasters; the unfortunate colonists being finally compelled to return to their native land, greatly reduced in number and weakened by disease, and after being harassed by the Spaniards and Indians. At this point the boat enters the Escondido

River. On each side the luxuriant and dense vegetation overhangs the water, a virgin jungle, whose somber shade the brightest sunlight fails to pierce. Flaming red herons rise and flutter or stand in comic solemnity watching us as we pass; gaudy macaws flash their flaring plumage among the leaves and utter hoarse cries as the boat wends its way; close to the shore, among the fallen trees and snags, huge alligators, innocent as yet of a knowledge of rifle ball or hunter, lift their ugly beaks in mute wonder at our intrusion upon their gloomy retreat. Indeed, a river trip is not necessary to see all this, a mile back of the town of Bluefields is the same impenetrable jungle. A meeting with a native tiger or jaguar is not an unusual occurrence in the outskirts, while in the rainy season, alligators from the lagoons are not too timid to carry off pigs and goats from the settlements.

After about twenty miles of steaming through those dark and gloomy channels, it is a pleasurable sensation to come upon the first clearing and see once more a sign of human activity. On every side are now evidences of thrift and industry. The picturesque houses of the planters, built of bamboo after the pattern of the native shacks and thatched with palm leaves, standing under the shade of tall cocoanut trees, make an ideal picture of tropic life. As the steamer lies to, for the purpose of landing supplies at many of the banana plantations, an excellent opportunity is given to study the manner of cultivation, if such it can be called. The only implement used by the cultivators is the machete, the universal native tool and weapon all in one; it is a rather long and broad knife, something between a broadsword and a cleaver in appearance. With the aid of this implement the native first clears the land of jungle and brush, each man being required to cut at least one "task" (twenty square yards) per day. Although this is only two or three hours' work, it is seldom that a native will do more than one task in a day. The natural inclination to work is of the faintest character. Nature has so bountifully provided all the necessaries of life that there would be no incentive to make money were it not for the passion for gambling, and a game of chance is the one thing the natives never seem too tired to engage in. The brush thus cleared is burned during the dry season and the ground is now ready for the young plants or shoots. These are "suckers" taken from older trees, and after planting them singly at distances of about eight feet apart, nothing further is required than occasionally to clear out the large weeds which will crop up between them. In two years the trees mature, reaching a height of ten to fifteen feet and bearing from one to three bunches each.

There is no such thing as a crop or a harvest as we understand the term with our northern possessions. Every day in the

year is seed time, every day is harvest time. Plants in various stages of maturity, plants in flower and in fruit and ready for the machete, stand side by side, and there is no winter to interrupt the process of vegetation. While the fruit is still quite green the plant is cut down, and the bunches being removed, these are carried to the river bank, where they are made into heaps and covered with the large leaves of the plant, so that the rain and sun may not unduly hasten the ripening. Only the largest bunches are reserved; the others are thrown into the river and left to drift away with the current.

THE HOUSE IN A TREE.—Rama is a town of about eight hundred inhabitants and, like Bluefields, is dependent chiefly upon the banana industry for its prosperity. It is situated right on the boundary line between the Mosquito Reservation and Nicaragua, and its population is a cross-breed of Spaniards and Indians. While at Rama I heard of a mysterious individual, a white man, who makes his home in a tree. Satisfying myself as to the substantial truth of the rumors, I determined to have a sight of the strange house of this eccentric person.

As the river steamer Hendy was to make a trip up the Rama River the following morning, passing the house in the tree, I accepted the invitation of Captain Tucker to accompany him. The captain was a typical Yankee, who had lived several years on the rivers of Nicaragua, and whose fund of information seemed inexhaustible. He kindly offered me his guidance to the house. After steaming several miles we came upon the "clearing" of Captain Henry Wilderson, for such is the name of the tree-dweller; and here, within a hundred yards of the river, stood this remarkable structure, its white painted sides and green window blinds making a striking object against the dark jungle surrounding it. Imagine a tall tree trunk nearly four feet in diameter and stripped of branches, rising fifty feet or more straight up into the air, and perched upon its summit this strange abode, looking for all the world like a huge lantern. It is said that Wilderson objects to visitors on curiosity bent, and a photographic camera pointed at the house would be quite apt to bring forth protests from the inmate, backed up if necessary by force and violence. Fortunately, on the day of our visit the captain was not at home, so our investigations were carried on without interruption. The tree upon which the house is built is a variety called the ebo; its wood is of great strength and hardness, and, as it would require days of work with an axe to fell it, Wilderson can feel quite safe on his lofty perch. The building is about twenty-five feet square and about the same in height. The tree runs completely through the center of the house to the roof. The first story is occupied by the kitchen; a sitting room and bedroom, with a small piazza facing the river, take

FIG. 5.—BANANA PLANTATION.

up the next story; while the third story was intended for a bath-room and observatory. The whole is very solidly built of pine lumber. At each corner are heavy braces of timber reaching from the ground to the main floor, while four stout guy-ropes running from the house and fastened to adjacent trees assure the occupant additional safety against the strong winds which sometimes rage. To reach the house it is necessary to enter an elevator placed at the back of the tree. This is a simple contrivance, and consists of a small platform to which is attached a rope passing over a pulley in the kitchen. To pull one's self up requires but little exertion, as the weight of a person is balanced by a heavy counter-weight, which descends as the elevator rises by a hand-over-hand pull of the passenger, and in a few moments one is landed at the door opening into the structure. In descending, of course, the operation is reversed. The interior is furnished in very plain style and may be said to contain necessaries only; there is not the slightest attempt at ornament or decoration. The kitchen utensils are few and most of them of home manufacture; indeed, Nature in this country has supplied food in such form that cooking is a matter of secondary importance, and is not regarded as one of the serious affairs of the household. As rain falls almost continuously for nine months of the year, the house is not without its supply of water. This comes from the roof and is run into tanks conveniently placed within the house. Captain Wilderson, who is an old Louisiana planter, built his castle in a tree about three years ago, and it is said to have cost thirty-five hundred dollars. The oddity is the result of a theory which the captain has that germs of malarial fever are not as active at an elevation as they are near the ground. Wilderson is said to be hale and hearty, and in consequence thereof his theory has quite a respectable local standing.

PEARL CITY.—Travel about the rest of the reservation is not as easy as the trip to the banana district by the river steamer. The lagoons along the coast are not all connected by water, and to reach one from the other it is necessary to cut your way across the intervening land through the jungle. The swath thus cut with the machete may be said to answer a double purpose, as, besides enabling one to make progress, it leaves a trail by which one can return to the point of starting, thus diminishing the very serious consequences of becoming lost. As already stated, however, traveling is nearly all done by water. The inland water communication through the lagoons along the whole two hundred miles of coast is interrupted in only two places, and the rivers running into the interior are numerous. The native boats, which are large dugouts, called "pitpans," are hollowed out of trunks of the ceiba or silk-cotton tree. These trees when in bloom are a

novel spectacle. It is certainly something out of the common to see a gigantic tree, with a trunk five or six feet in diameter and eighty or ninety feet high, and sending out limbs as long and massive as an oak, yet bearing flowers like a rose bush. These

FIG. 6.—GATHERING BANANAS.

flowers are rich and variegated in color, but chiefly of a bright carnation. Viewed from beneath, they are scarcely visible; the fragrance is overpowering, and the ground is carpeted with their gay leaves and delicate petals. When seen from a little distance, the ceiba tree in bloom is one of the most splendid productions of Nature—a huge and brilliant bouquet, requiring a whole forest to supply the contrasting green. The wood of the ceiba is easily worked, and, moreover, is light and buoyant and not liable to split by exposure to the sun. It is these qualities which make it so valuable for building the different varieties of boats required on the coast. The boats are usually sent from the interior in a rough and partly finished condition, being simply dug out, the outside being left to be finished according to the taste and fancy of the future owner. The boats are commonly fifteen or twenty feet long and about two feet wide, but it is not unusual to meet them of much larger dimensions, sometimes reaching even the great length of one hundred feet. The ends rise gracefully from

the water, presenting an overhanging bow and stern exactly alike in shape. Although the natives paddle about in all kinds of seas and weather, to the novice the boats are most frail and cranky craft; the slightest demonstration is sufficient to careen them to the very verge of capsizing. When such an accident does happen, the natives, who are excellent swimmers, right the boat and, by dexterously shaking it from side to side, empty it of water, and then, jumping in, they will pursue their journey with the utmost complacency. They propel their canoes with large shovel-shaped paddles, which they work for hours without signs of fatigue.

Pearl Lagoon is the sheet of water immediately north of the lagoon of Bluefields. The two are separated by a neck of land known as "Haulover." Pearl City, the home of the chief, is situated on the banks of Pearl Lagoon, and is about thirty-five miles from Bluefields. Much of the journey is through dark, winding creeks, and nowhere on the trip, until the settlement at Pearl La-

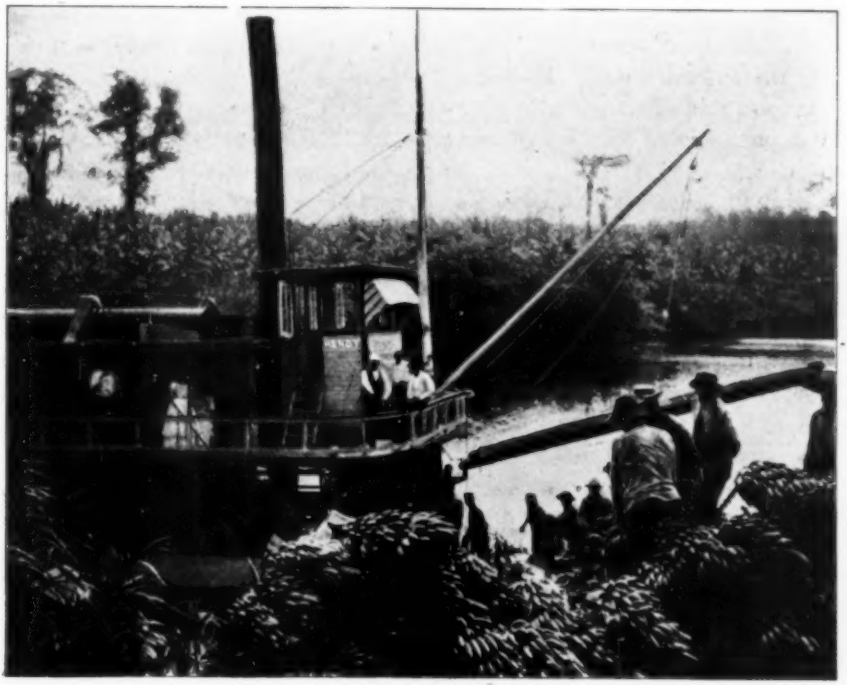

FIG. 7.—LOADING BANANAS.

goon is reached, can the slightest trace of civilization be seen. Pearl City is a far prettier place than Bluefields, and is built on a prairie or savanna of some six square miles in extent. I was cordially received by Robert Henry Clarence, the Mosquito chief, who placed at my disposal one of his three horses, and I had

the pleasure of the company of his Excellency on a canter over the plain. The little chief proved a furious rider, and spurred his horse to a breakneck gait, so that I had the greatest difficulty to keep up with him. Jumping from his horse, he disappeared for a moment in the brush, and presently returned with some luscious pineapples, which he peeled and, cutting lengthwise, offered me to eat. Among the institutions at Pearl City is the brass band of fourteen pieces. The band is under the leadership of Mr. J. W. Cuthbert, Jr., the Secretary of the Executive Council of the Mosquito nation. The Sambos performed for our edification and to their own satisfaction for at least two hours. Among the tunes were some which I recognized as having done long service on our variety stage.

The genuine Mosquitos, although they number over six thousand, are rarely met with at the coast settlements. They do not care to observe the restrictions put upon them by the local authorities in clothing themselves. Scantiness of dress is characteristic of a true Mosquito Indian, and in the interior of the country they can be observed in all their natural simplicity of costume. It must be admitted that for this hot, moist climate this is not an unreasonable state of affairs. I was fortunate in securing pictures of a number of groups of natives, both of the true Mosquito and of the Sambo variety, and some of these, with a picture of a native "shack" or bamboo house, are shown in the illustrations. Besides the banana and mahogany, the Mosquito country has other valuable resources. In its northern portion the country has extensive savannas covered with luxuriant grass the whole year round, affording admirable opportunities for cattle-raising. This business is yet in its infancy, but promises to assume respectable proportions. Cotton blooms wild and will bear through the entire year; sugar cane will produce a crop every seven months; rice, every four months; and oranges, lemons, limes, pineapples, and a host of other fruit grow wild. The upper runs of the northern rivers and creeks have gold-bearing sand, and it is not impossible that some day the "Reserve" will take rank as a gold-producing country.

THE "amber and jade" mines of Upper Burma have been visited by Dr. Noettling, who has reported upon them to the Geological Survey of India. The "amber" is a fossil resin corresponding with that called burmite, fluorescent, looking like solidified kerosene oil, and darker and harder than ordinary amber. The "jade" is jadeite, worked in pit and quarry mines for forty miles along the bank of the Uru River and on the top of a plateau at Tammaw. The industry is a thriving one, employing five hundred men, and promises well for future more systematic and skilled development. White is the commonest color; green is rare; and some of the bowlders are red.

WEISMANN'S CONCESSIONS.

By LESTER F. WARD.

NEARLY three years ago, and before the appearance of the second volume of Weismann's Essays,* in a Critique of Weismann,† based entirely on statements contained in the first volume, I intimated that in my judgment he had already admitted enough to invalidate his doctrine of the non-transmissibility of acquired characters where these are of a functional nature. After showing from his own language that, according to his theory, no variation would be possible later than the Protozoan stage of development, which was a *reductio ad absurdum*, I proceeded to point out that, apparently from a sense of this position, he had actually admitted the possibility that external influences may affect the germ. One of the passages embodying such an admission is the following:

"I believe, however, that they [hereditary variations] can be referred to the various external influences to which the germ is exposed before the commencement of embryonic development. Hence we may fairly attribute to the adult organism influences which determine the phyletic development of its descendants. For the germ cells are contained in the organism, and the external influences which affect them are intimately connected with the state of the organism in which they lie hid. If it be well nourished, the germ cells will have abundant nutriment; and, conversely, if it be weak and sickly, the germ cells will be arrested in their growth. It is even possible that the effects of these influences may be more specialized; that is to say, they may act only upon certain parts of the germ cells." ‡

In the same essay, speaking of the influence of climate, he also uses language that has a decidedly Lamarckian sound:

"It is difficult to say whether the changed climate may not have first changed the germ, and if this were the case the accumulation of effects through the action of heredity would present no difficulty." ‖

Upon this, my comment was:

"I can not see why this is not conceding the whole issue. Of

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* Essays upon Heredity and Kindred Biological Problems. By Dr. August Weismann. Authorized Translation. Oxford: At the Clarendon Press. Vol. i, 1889; vol. ii, 1892.

† Neo-Darwinism and Neo-Lamarckism. Annual Address of the President of the Biological Society of Washington, delivered January 24, 1891. Proceedings, vol. vi, Washington, 1891, pp. 45–50.

‡ Essays, vol. i, pp. 103–104.

‖ Ibid., p. 98.

course, all modifications must first affect the germ, otherwise there could be no hereditary transmission. The only question is: Can the climate or the environment impress changes upon the germ? If yes, the Neo-Lamarckian asks no more. All that he contends for is conceded." *

In his later work on the Germ-Plasm,† Prof. Weismann says that I am in error if I suppose that "the proof that climatic influences are capable of modifying the germ-plasm contains all that is required by the Neo-Lamarckian school." It is true that climatic influences in the restricted sense are not the only ones that Neo-Lamarckians suppose to act directly upon the germ. They maintain that *functional* variations are heritable to a greater or less degree, and make the chief distinction between these and *accidental* variations, such as mutilations and other injuries. The principal stress has hitherto been and still continues to be laid, by both Prof. Weismann and his followers, upon the latter class, which is therefore a waste of words and a mere show of argument calculated to deceive those who have little acquaintance with the subject. But when it comes to modifications of form which are brought about by the efforts and struggles of the creature to obtain its sustenance or accomplish desired ends, the case is wholly different. Such modifications are necessarily complex and involve a harmonious adjustment of all the parts that are brought into exercise, which, when transmitted, secures the complete and systematic variation which species are believed to undergo. Climatic influences are among the most important ones against which the creature thus reacts, but the entire environment may be regarded as constantly impinging, so as to bring about perpetual modifications.

In the second volume of his Essays there are further concessions in this same general direction. In his reply to Prof. Vines, he is compelled to admit that variation may take place in different forms of asexual reproduction, which is a practical abandonment of his theory of the continuity—i. e., of the unalterable nature—of the germ-plasm. He is apparently willing to "concede that some amount of individual variability can be called forth by direct influences on the germ-plasm."‡ Surely a discussion as to the "amount" of such variation is a radically different thing from a discussion as to whether it can take place at all. The principle at issue is shifted when such an admission is made.

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* Neo-Darwinism, etc., p. 58.

† The Germ-Plasm: A Theory of Heredity. By August Weismann. Translated by W. Newton Parker and Harriet Rönnfeldt. New York: Charles Scribner's Sons, 1893. Contemporary Science Series. See p. 408.

‡ Essays, vol. ii, p. 95.

But this was only a beginning of the almost complete retreat that he has now made in his last work on the Germ-Plasm. As before, it seems to have been the phenomena which the vegetable kingdom presents that most obstinately refuse to adapt themselves to the mechanical theory of heredity of which he is the author. Before these facts his fundamental distinction between the blastogenic and the somatogenic idioplasm breaks down completely, and here at least he is "compelled to assume that *most*, if not all, of the *cells contain all the primary constituents of the species in a latent condition.*" * After carefully considering such cases as those of Bryophyllum and Begonia, almost any part of which may be made to grow if properly situated, he admits that such observations "apparently prove that 'every small fragment of the members of a plant contains the elements from which the whole complex body can be built up, when this fragment is isolated under suitable external conditions.'" †

Before passing to the major admissions of Weismann it may be well to mention a few of the "doubtful phenomena of heredity" which, in case they really occur, form such a stumbling block to his system. On this side of the water one is amused at the statement that "blue grains occasionally occur among the yellow ones in cobs of the yellow-grained maize (*Zea*) after fertilization with the pollen of a blue-grained species." ‡ There is probably only one "species" of Indian corn, but the cultivated varieties are endless, and every farmer's boy knows that it is of the greatest importance to keep these apart, so that the ears will "fill" with the same kind of kernels. Few American farmers would hesitate to stake their farms on the much more than "occasional" occurrence of different kinds of kernels on the same cob in a field where different varieties are planted together.

As regards the numerous cases of the alleged transmission of characters derived from one sire to the offspring of a subsequent sire, though disposed to discredit the evidence, he nevertheless admits their possibility to a limited extent. For he says of them: "We may, however, at any rate suppose that this so-called 'infection,' if not altogether deceptive, only occurs in rare instances, and by no means regularly, or at most only in some cases." §

Here we have again, as in the general case above considered, a characteristic Weismannian argument, shifting the point from the qualitative to the quantitative, from the principle to the degree, which reminds one very forcibly of Jack Easy's wet nurse

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* The Germ-Plasm, p. 206. The Italics are his in this and all subsequent passages.

† Ibid., p. 212. The words quoted by Prof. Weismann appear to be taken from De Vries.

‡ Ibid., p. 383.

§ Ibid., p. 385.

Sarah, who sought to excuse the illegitimacy of her child by the plea that "it was a very little one." In his reply to Mr. Herbert Spencer's articles * he has made matters worse by explaining it on the supposition that "spermatozoa occasionally reach the ovary, and there enter into some of the immature eggs. Amphimixis can not proceed, as the germ-plasm of the egg is not ripe, but the nucleus of the sperm cell continues to live in certain circumstances, and so remains till the time of a subsequent *coitus* with another mate." †

It is obvious that in such a case the "subsequent *coitus*" need have nothing to do with the matter; whenever the egg was ripe there would be nothing to prevent amphimixis taking place, followed by all the stages of ontogeny, and we should have a case of parthenogenesis in the mammalia. If this were possible in the human race it would create something of a ripple in the social world.

Prof. Weismann does not deny that certain diseases, especially germ diseases, are hereditary and directly transmissible in the first instance, and he admits that this has "definitely been proved to occur in the case of syphilis. The father, as well as the mother, is capable of transmitting this disease to the embryo, and the only possible explanation of this fact is, therefore, that the specific bacteria of syphilis can be transmitted by the spermatozoön." ‡ But he will not admit that this constitutes a case of the transmission of acquired characters, undertakes to connect it with the adaptation of the parasite to the host, and concludes:

"It will, I think, at any rate be conceded that a 'constitutional' disease can not be taken as a proof that the processes of heredity are therein concerned until we can determine whether we are actually dealing with heredity—i. e., the transmission of a constitution—and not only with a transference of microbes." *

This all seems very absurd to the average reader, and conveys the impression that the scientific discussion of these questions has, after all, no interest for the public, and only amounts to a useless hair-splitting on the part of the doctors. For what matters it to the consumptive whether his case is one of "the transmission of a constitution" or "the transference of microbes"? Mr. Spencer, in the articles above referred to, has sufficiently characterized the reasoning which allows a microscopically visible microbe to pene-

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* The Inadequacy of "Natural Selection." Contemporary Review for February, March, and May, 1893; reprint, London, Williams & Norgate; New York, D. Appleton & Co., 1893, p. 69.

† The All-sufficiency of Natural Selection. A Reply to Herbert Spencer. Contemporary Review for September and October, 1893, p. 609.

‡ The Germ-Plasm, p. 388. * Ibid., p. 391.

trate tissues through which even biophors can not pass; and Prof. Weismann, in showing that the latter must break out of jail, should also explain how the former are able to break into jail. Taking all these things into account, I am constrained to repeat a former remark, that "if the term 'acquired' is to be any further refined away, then discussion is useless, for it is not a mere dispute about a word that interests us, but the fundamental question whether external conditions do or do not permanently and progressively influence the development of organic beings." *

Reverting, then, to the main question as to the influence of external conditions on the germ, I would remind the reader that in his essay on amphimixis, originally published in 1891, Prof. Weismann held that "*a belief in the inheritance of acquired characters by the highly differentiated Protozoa, as well as by Metazoa, must be opposed,*" and imagined that "*the phyletic modifications of Protozoa arise from the germ-plasm, that is from the idioplasm of the nucleus*"; † and he further says:

"My earlier views on unicellular organisms as the source of individual differences, in the sense that each change called forth in them by external influences, or by use and disuse, was supposed to be hereditary, must therefore be dismissed to some stage less distant from the origin of life." ‡

He then ascribed all variations above this early stage to amphimixis and sexual reproduction. In the new work he indeed reiterates this view, and says that these processes furnish "an inexhaustible supply of fresh *combinations* of individual variations which are indispensable to the process of selection." * But he now introduces the following important qualification:

"Although the process of amphimixis is an essential condition for the further development of the species, and for its adaptation to new conditions of existence among the higher and more complicated organisms, *it is not the primary cause of hereditary variation.*" ‖

He then proceeds to explain the change that has taken place in his mind, obviously while writing this book, admits that he had overestimated the power of sexual reproduction to modify species, and shows that though the general result might be changed there could be no variation in the determinants themselves, "which alone could gradually lead to a transformation of the species." Not only is amphimixis incapable of modifying the determinants, but it is also, and for the same reason, incapable of increasing the number of kinds, yet on his general theory these

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* Neo-Darwinism and Neo-Lamarckism, etc., p. 59.

† Essays, vol. ii, p. 192.

‡ Ibid., p. 193.

* The Germ-Plasm, p. 413.

‖ Ibid., p. 414.

must be enormously increased with the development of every species. A new principle must therefore be found to explain the observed fact. Strangely enough, he finds this principle to be none other than the Lamarckian law of the effect of external conditions in modifying the hereditary elements!

"Amphimixis alone could never produce a multiplication of the determinants. *The cause of hereditary variation must lie deeper than this; it must be due to the direct effect of external influences on the biophors and determinants.*"*

It is easy to see that this is a complete abandonment of his fundamental doctrine of the immutability of the germ-plasm, and here again he shifts the point of the argument to the quantitative, and would have us believe that it was the same thing to say that it possesses "great power of remaining constant." But he adds:

"We can none the less avoid assuming that *the elements of the germ-plasm*—i. e., the biophors and determinants—*are subject to continual changes of composition* during their almost uninterrupted growth, and that *these very minute fluctuations, which are imperceptible to us, are the primary cause of the greater deviations in the determinants, which we finally observe in the form of individual variations.*"†

These variations that take place in the hereditary elements he ascribes to "the impossibility of a complete uniformity as regards nutrition existing during growth," or to "the modifying influence of nutrition." The following passage is as complete an admission of the Lamarckian principle as any one need wish, while at the same time it illustrates over again his characteristic tendency to evade the issue by maintaining that its influence is small compared to that of some other principle:

"Even though it can no longer be doubted that climatic and other external influences are capable of producing permanent variations in a species, owing to the fact that, after acting uniformly for a long period, they cause the first slight modifications of certain determinants to increase, and gradually affect the less changeable variants of the determinants also, the countless majority of modifications is not due to this cause, but to the processes of selection."‡

In this passage there is a curious psychological implication in the expresssion "no longer," which obviously refers to the changes in his own mind, that are by him projected to the world at large, which, as a matter of fact, has from the first intuitively arrived at the conclusion which has cost him such a great cycle of elaborate reasoning. This new theory of his as to the origin of variations is summed up in the following paragraph:

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* The Germ-Plasm, p. 415. † Ibid., p. 417. ‡ Ibid., p. 422.

"*The origin of a variation* is equally independent of selection and of amphimixis, and is due to the constant recurrence of slight inequalities of nutrition in the germ-plasm which affect every determinant in one way or another, and differ even in the same germ-plasm—not only in different individuals but also in different regions. These variations are at first infinitesimal, but may accumulate; and, in fact, they must do so when the modified conditions of nutrition which gave rise to them have lasted for several generations. In this way deviations may occur in the structure of single determinants or of groups of them—never, perhaps, in all ids at once, but at any rate in several or even many of them. A doubling of certain determinants of the germ-plasm may originate in the same way. The process of amphimixis has an important share in the accumulation of these modified determinants, for it may raise the minority previously existing in the two parents to a majority by combining their halved germ-plasms. Then, and then only, does selection begin to take place." *

After all this it is certainly surprising that he should still cling to his former declaration that acquired characters are not transmissible. After abandoning all his premises he still adheres to his conclusion. Dr. J. G. Romanes, who has been one of his most liberal critics, after characterizing the latter part of the Germ-Plasm as "a right-about-face manœuvre," says that his first impulse "was to cancel all the criticisms which I had written of the Weismannian theory," † and it really seems as though it were time to drop this prolonged discussion. Its further continuance must certainly be chargeable to his own course as pursued in Chapter XIII of his Germ-Plasm, and in his reply to Mr. Spencer in the face of these concessions. It is somewhat difficult to understand how he is able to reconcile these apparently conflicting views. That he does not limit the influence of external conditions to the germ-plasm proper, or fertilized germ cell, is apparent from his cheerful acceptance of Nägeli's "opinion that all variations are slowly prepared in the idioplasm in the course of generations before they become apparent," and we must suppose him to admit that it is the hereditary units themselves that are undergoing these transformations. In my address before the Biological Society I had referred to this in the following language:

"You will understand that I am speaking of variations which take place in the germ cells and sperm cells of parental organisms before they blend in the fertilized ovum. Most of Weismann's argument is directed to show that the fertilized ovum itself can not be affected by any transforming influence acting upon the

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* The Germ-Plasm, p. 431.

† The Open Court, vol. vii. Chicago, September 14, 1893. Supplement, p. iii.

mother during the growth of the embryo. This may be true, but it is unimportant. The time required to develop the embryo is too short for the environment to produce any material change however strong the tendency might be at the time in the direction of such change. It is chiefly the uncombined sexual elements which are admitted by all to be undergoing specific transformation." *

This is the main issue, and if admitted, the Neo-Lamarckian asks no more. How then does Weismann evade this issue? He says:

"It is self-evident from the theory of heredity here propounded, that only those characters are transmissible which have been controlled—i. e., produced—by determinants of the germ, and that consequently only those variations are hereditary which result from the modification of several or many determinants in the germ-plasm, and not those which have arisen subsequently in consequence of some influence exerted upon the cells of the body. In other words, it follows from this theory that *somatogenic or acquired characters can not be transmitted.*" †

From these and other statements we are obliged to infer that while he admits the power of external influences to affect the somatic cells at all points where they impinge, adapting the organs of the body to the environment, and also admits that inequalities of nutrition (which at bottom are the same thing) modify the germ cells, he denies that these two facts have any connection with each other. Obvious as it is that the species becomes modified to suit the changing environment just as does the individual, he attributes the former wholly to natural selection and the latter wholly to direct adaptation. All, therefore, that is gained by this latter process is necessarily lost, and we have a strong indictment against Nature, "who," he says, "always manages with economy." ‡ It seems far more logical to argue from the economy of Nature and the parallelism of these two processes for a causal connection between them.

But it must not be forgotten that he now makes natural selection itself entirely dependent upon "inequalities of nutrition" in the germ-plasm as its universal antecedent. Is this then so widely different from the direct adaptation that takes place in the somatic cells? Let us see how narrow the distinction grows with careful analysis. He admits that alcohol affects the germ and sperm cells by debilitating them and makes weakly children. He would admit the same of any deleterious drug. He would not deny that any disease that debilitates the parents

* Neo-Darwinism and Neo-Lamarckism, etc., p. 49.

† Germ-Plasm, p. 462. ‡ Ibid., p. 63.

would have a similar effect. These agencies may be regarded as the opposites of nutrition—i. e., as constituting part of the "inequalities of nutrition" that affect the germ and cause it to vary. Variations in the germ-plasm are necessarily quantitative, more or less, according as nutrition is abundant or deficient, and all qualitative differences must be due to the external influences affecting certain constituents more strongly than the rest. How, then, does this differ from pure Lamarckism?

When we say that an organ is strengthened by use, there is obviously an ellipsis. What we mean is that exercise increases nutrition and nutrition strengthens the organ. We may be even more explicit and say that exercise causes increased circulation to the part exercised, causing more tissue to be deposited, thus enlarging and strengthening the organ. Lamarck, of course, understood all this, but did not think it necessary to explain these elementary principles. It is the same with the influence of climate and of the environment in general. All these agencies produce variation by affecting nutrition. If defective nutrition can affect the germ-plasm, why can not abundant nutrition affect it? How does the germ get its nutrition except in the same way that all the other cells of the body get theirs, through the food supply? Is the germ "immortal" in the sense that, like spirit, it can subsist indefinitely upon nothing? If it depends upon sustenance from the body, it must receive its nutrition from the body, and the quantity and quality of that nutrition will vary as those of the body vary. That they do vary he admits, and makes this the very *fons et origo* of hereditary variation.

But it does not seem possible to Prof. Weismann that a specific variation of some organ or part of the body can influence the reproductive products in precisely the same way so as to perpetuate that variation in the progeny. That we can not understand this may be freely admitted. It is the essence of the mystery of heredity. We know that like produces like. If we abandon that principle, there will be no stopping short of the opposite one, that like produces unlike. It is the same in principle to say that horses may produce cattle as to say that robust horses may produce feeble ones, although the robust ones may have acquired their robustness, not formerly possessed, through proper food, care, and treatment. And there is still no difference in the principle if, instead of robustness, the character be some specific one, such as a "racking" gait, which might be acquired during the life of a single individual. Such qualities are often transmitted. So, too, are the colors of flowers, which can be changed by adding certain ingredients to the soil, as are also certain artificially enforced habits in plants, such as are engendered by "layering," etc. But these are characters only feebly impressed and can not be expected

to persist unless carefully aided by artificial selection, yet they *must* have commenced as acquired characters. Well-broken horses and well-trained dogs transmit these qualities to their offspring, and all domestication and cultivation of animals and plants, all changes wrought in them by man, must have been first acquired to some degree, and then, by intelligent selection, the degree can easily be increased. Like produces like, and if we can not explain why, it is because we have not yet solved the problem of heredity. The elaborate theory offered by Prof. Weismann in his Germ-Plasm, plausible as it sometimes seems, true as it doubtless is in many of its details, utterly fails to solve this problem. It is altogether too rigid, too mechanical, to explain such subtle phenomena. Nature is more flexible, more self-adjusting, more delicate than his system contemplates, and is constantly doing just those things which he insists can not be done.

I trust that it has been sufficiently shown, chiefly from his own words, that in elaborating this complicated theory Prof. Weismann, guided, as he always seems to be, by the highest regard for truth, has, greatly to his credit, conceded all the essential points in the long controversy as to the inheritance of acquired characters. The discussion may therefore be regarded as narrowed down, not so much to the relative importance of the direct and indirect factors, as to the degree to which in any given case the one or the other has operated in determining the observed result.

THE CINCINNATI ICE DAM.

By G. FREDERICK WRIGHT,
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IN many respects the Ohio is one of the most remarkable rivers in the world. Its drainage basin comprises about two hundred thousand square miles on the northwestern slope of the Alleghany Mountains. Its eastern tributaries rise at an elevation of something over two thousand feet above the sea, and hence are so situated as to carry the rainfall and the melting snows with great rapidity into the main channel, which at Pittsburg is seven hundred feet above the sea, and at Cairo, where it unites with the Mississippi, about three hundred feet; the descent from Pittsburg to Cairo being about four hundred feet in a distance, as the river runs, of nearly a thousand miles.

The whole course of the river is through sedimentary rocks, which, though of Palæozoic age, have been but slightly disturbed. The elevation of the region has been so continental in its proportions that the rocks have retained to a great degree their original

horizontal position. Through these comparatively horizontal strata the Ohio River has worn a gorge of remarkable uniformity, and several hundred feet in depth. Even to the ordinary observer it is clear that this trough is one of erosion; for the strata of rock upon one side of the river match those upon the other as precisely as do the two ends of a board which has been sawed apart. The seams of sandstone, coal, and lime rock upon one side correspond to similar seams upon the other; while the river does not pursue a straight course, but follows, throughout, a very tortuous channel, such as is begun by the meandering of a stream over a nearly level surface.

The width of this rocky gorge is from a quarter of a mile, where the rocks are peculiarly hard, to a mile or over, where they are more easily disintegrated. For the most part, also, the tributaries occupy corresponding gorges, with a width contracted to the proportion of the individual drainage basins. At the junction of the main stream with the tributaries there is usually an enlargement of the gorge such as would naturally follow from the combination of erosive forces which there occurs. These features of the trough of the Ohio and its tributaries give character to the scenery throughout its course. Nowhere from the decks of the steamer does one get an extended view on either side. Everywhere the vision is circumscribed by the hills, more or less precipitous, which rise close at hand upon both the right and the left; while the windings of the channel are such that no very distant views are obtained either before or behind. The railroads which connect the cities in the valley are compelled either to hug the side of the gorge between the river and the precipitous ledges, or to strike up some one of the tributaries, and then, after crossing the country for a while, follow down another to the level of the main stream. The land a little back from the trough of the river is very broken and hilly, since all the affluents of any size have eroded channels for themselves down to the depth of the principal gorge.

Above Louisville, Ky., the large cities upon the Ohio strikingly reveal the limitations imposed upon them by the character of the river valley. Having begun as a cluster of houses upon the river's bank, they have gradually spread back upon it, until reaching the base of the rocky precipices. With the rapid growth both of population and of improvements in later years, Cincinnati and Pittsburg have literally overflowed their banks and risen to the summit of the hills on either side, the inhabitants being transported from their places of business to their residences by long inclines up which the street cars are drawn at a steep angle to a height of from three to five hundred feet, from which positions extended views are given in every direction over the

Map I, showing the 500-foot and the 1,000-foot contours of the Ohio Valley; also the boundary of direct glacial action and the approximate limits of the slack water produced by the Cincinnati ice dam. The figures give the elevation above the sea. Those along the river refer to the low-water mark. In the lower right-hand corner is a typical section of the Alleghany, showing the rock channel and the high-level terraces.

broken surface whose summits represent the once comparatively level area. At Parker City, Pa., an elevator was once used to lift foot travelers from the lower terrace to the upper terrace, two hundred feet above.

Although flowing in so deep a trough, the present Ohio River is considerably elevated above the ancient bottom. This is owing to the fact that during the Glacial period such an excessive amount of gravel was brought down from the Alleghany River and other northern tributaries that the old channel was silted up to a considerable depth. At Cincinnati there is more than one hundred feet of gravel between the present river bottom and the rock bottom. Below the mouths of the most important northern tributaries the accumulations were much greater than this. At Cincinnati the channel was choked with gravel from the Little Miami to a height of one hundred and twenty feet above the present river. Subsequently this was partly eroded away, leaving the one-hundred-and-twenty-foot gravel terrace which is now occupied by Fourth Street.

It is fortunate for civilization that there are left along the trough of the Ohio numerous remnants of this high-level glacial terrace; otherwise the cities would be even more subject to damage from floods than they are now; for the Ohio River is subject to greater fluctuations of level than almost any other stream in the world. During the flood of 1884 the water rose at Cincinnati seventy-one feet, submerging the railroad stations and much of the lower part of the city, but leaving that portion which was upon the glacial terrace fifty feet above water. The cities which were not favored with so marked a gravel terrace, or had not taken advantage of their opportunities, were for many days turned into miniature Venices, the lower stories of the houses being generally submerged by the muddy torrent, and boats being able to pass freely through all the streets.

The cause of these enormous floods along the Ohio is readily perceived; for, as already remarked, the slope of the streams rising along the summit of the Alleghany Mountains and flowing into the Ohio is so rapid that the water from the rains and melting snows finds its way into the main trough of the river in an incredibly short time, while the trough is so narrow in places, especially just below Cincinnati, as greatly to impede the progress of the current. Two or three inches of rainfall over two hundred thousand square miles provides an enormous quantity of water, which, upon being suddenly transferred to the river channel, turns a stream which can sometimes be forded in dry weather into a steadily advancing column of water one thousand miles long and from fifty to seventy-five feet deep. It is interesting to watch from the weather bulletins the progress of the waves that move down the

Ohio upon the unusual rise of any of its upper tributaries. At Pittsburg thousands of coal barges collect during low water to take advantage of these waves of translation, and move forward upon them with their valuable freight like a vast army to supply the great cities of the Mississippi Valley with fuel. But, as with

FIG. 1.—JASPER CONGLOMERATE BOWLDER, THREE FEET IN DIAMETER, FROM NORTH OF LAKE HURON. Found near Union, Boone County, Ky. (See Map II.) From photograph by the author, reproduced in The Ice Age of North America, p. 328.

everything else, the best gifts of Nature are those which come in moderation. Enough is better than more. Excessive floods interfere with navigation as effectually as does a lack of water.

With these facts in mind, while surveying, in the year 1882, the glacial boundary across the Mississippi Valley, I reached Cincinnati, having traced the border line to the river twenty-five or thirty miles above the city. Upon crossing to the general level of the hills in Kentucky, I found various indubitable evidences that the ice had extended across the trough of the Ohio, and left its marks several miles south of the river over the northern part of Boone County, and up to an elevation of more than five hundred feet above low-water mark. This was along the watershed between the Licking and Ohio Rivers, which was continuous at this height to the central part of Kentucky. Among other evidences one of the most conspicuous was a bowlder of jasper conglomerate, three feet in diameter, found near Union, in Boone County, which was subsequently transported to Chicago as a part of the Ohio glacial exhibit at the Columbian Exposition. Its right to have a place in an Ohio exhibit was due partly to the fact that it was discovered by an Ohio man, but chiefly from the fact that, at

the snail's pace at which a glacier moves, this bowlder must have been in the territory of Ohio for an enormous period of time, long enough for even a bowlder to become naturalized. If, however, the Canadians should claim it as a fugitive from justice, they would have a prior right, for the ledges from which it was derived are near Thessalon, in Ontario, north of Lake Huron. In searching for bowlders in southern Ohio, I was accustomed to hear them referred to as "niggerheads." In the progress of discovery it was found that the numerous articles of that description which in recent times Kentucky had furnished to Canada were in payment of a debt under which the Dominion had placed the southern commonwealth long ages before.

It is important to note that my discovery of Canadian bowlders on the hills of Kentucky was not the first which had been made there. As far back as 1845 Prof. Locke had noted the post-glacial conglomerate called Split Rock, below Woolpert's Creek, opposite

FIG. 2.—SPLIT ROCK, NEAR MOUTH OF WOOLPERT'S CREEK, KY. This is part of an extensive deposit of bowlders and gravel with some Canadian pebbles, all cemented together by infiltrated carbonate of lime. From photograph by the author, reproduced in The Ice Age of North America, p. 345.

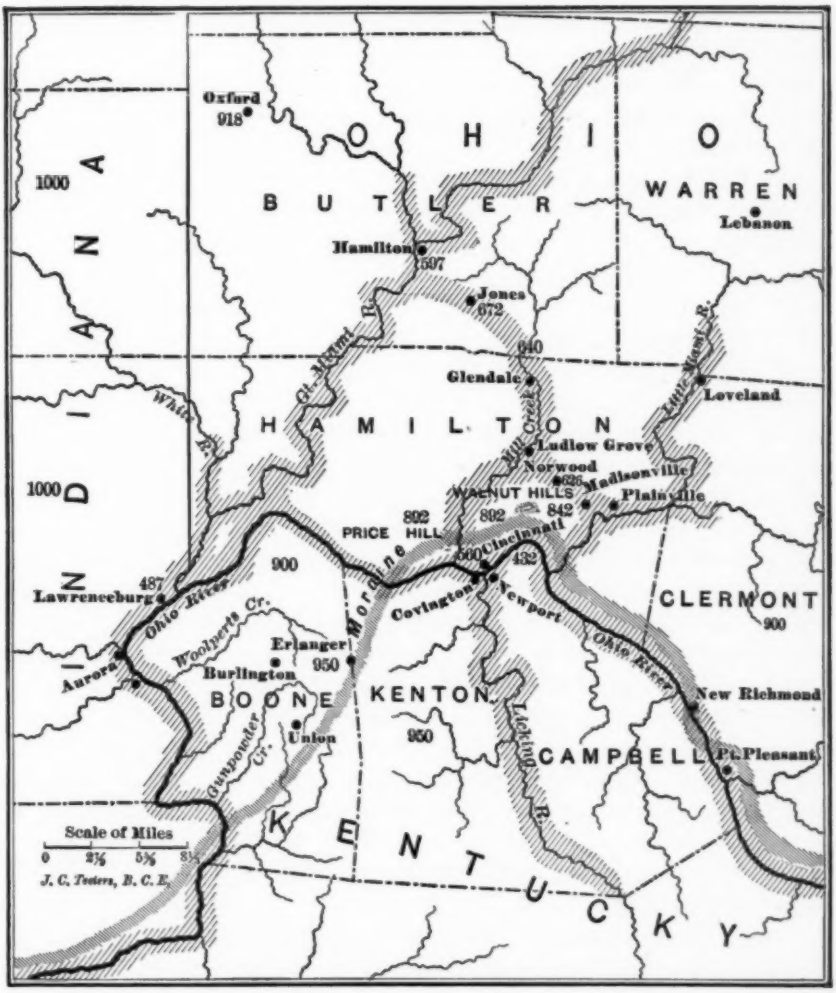
Aurora, Ind., but had regarded this as the remnants of local strata which had been nearly worn away. In 1872 also, Mr. Robert B. Warder had suggested that this was possibly a terminal moraine. Still later Dr. Sutton, in 1876, and Prof. Cox, in 1878, had noted similar deposits near the summit of the Kentucky hills, on Middle Creek opposite Aurora, and had attributed them correctly to glacial action during the maximum stage of the great

Ice period. But because of the imperfect knowledge of the glacial geology of the valley possessed at that time, these discoveries attracted little attention. Various causes, however, conspired to give a somewhat extraordinary notoriety to the facts as they were presented at the meeting of the American Association for the Advancement of Science at Minneapolis in 1883. At that time a systematic exploration of the glacial boundary had been conducted from the Atlantic Ocean to Cincinnati, showing that the Ohio River lay for the most part considerably south of the farthest extension of the ice. Also attention was then first called to the full extent to which the ice had crossed the river in that vicinity. For a distance of nearly one hundred miles it was now demonstrated that the ice came down to the north margin of the trough of the river, and for much of that distance crossed it and mounted the hills upon the opposite side, reaching at one point fully ten miles upon the high land beyond the river. This could not well help suggesting the formation of an ice dam at Cincinnati which would set the water back up the Ohio and its tributaries to the level of the watershed between the Licking and the Ohio, thus forming a narrow and tortuous lake several hundred miles long, which would be five hundred feet deep above Cincinnati and two hundred and fifty feet deep at Pittsburg. (See Map I.)

Finally, some of the geologists who had been engaged upon the survey of western Pennsylvania at once came forward and affirmed that such an obstruction as this supposed at Cincinnati helped to explain a great number of facts respecting certain high-level gravel terraces characterizing the Alleghany and Monongahela Rivers, which were surprisingly near the level of the water of the supposed glacial lake. At the meeting at Minneapolis Prof. Lesley, under whose vigilant eye the recent geological survey of Pennsylvania has been conducted, declared that he had for some time been expecting the discovery of a local obstruction to the drainage of the Ohio River which would account for the gravel terraces on the Alleghany and Monongahela to which reference has been made, and now, says he, Providence has provided it, and Wright's dam clears up the whole problem, or words to that effect.

Such was the boom with which the theory of the Cincinnati ice dam was brought before the public in 1883. During the ten years which have since elapsed, the hypothesis has been subject to much criticism, so that the faith of some has been shaken, and the theory itself is thought by many to be left in rather a damaged condition. The fullness with which the main facts have been already presented makes it possible to tell the remaining part of the story and state the present condition of the theory in few words.

So complicated are the forces of Nature that one discovery is sure to lead to another, and the man of science soon learns that he never exhausts attainable knowledge even in respect to the simplest subject, and the student has made little true advancement if he has not acquired ability to hold his mind wide open



Map II, showing the partly filled preglacial channel of the Ohio, extending from Cincinnati to the Big Miami at Hamilton. The figures show elevations above the sea.

for the reception of any and all additional facts which may modify and enlarge his theories. In the present case most interesting additions to our knowledge of the facts were made by Prof. Joseph F. James, who called attention to the breadth and depth of the valley running northward from Cincinnati to Hamilton, on the Great Miami River, and to the comparative narrowness and

shallowness of the present rocky gorge of the Ohio between Cincinnati * and the mouth of the Great Miami. The relative narrowness also of the latter opening between the rocky escarpments is readily visible to the transient traveler, Mill Creek Valley being about twice as wide as that of the Ohio for fifteen or twenty miles below the mouth of the creek; while a low passage joins Mill Creek at Ludlow Grove which sweeps around north of Walnut Hills, and enters the Ohio through the valley of the Little Miami—Walnut Hills, Mount Auburn, and Mount Lookout, the principal residence portions of the city, being upon a high, rocky pedestal completely surrounded by a depression which has at some time been produced by river erosion.

This valley from Cincinnati to Hamilton is now filled with gravel and clay to a great depth. Upon inquiring for the extent to which the old channel had been filled, it was found by the wells which had been sunk in it that the rock bottom descends from Cincinnati to Hamilton, and is considerably lower than the rock bottom of the present Ohio below Mill Creek. Near Ludlow Grove the bed rock is at least sixty feet below present low water in the Ohio. A few miles farther north, at Ivorydale, on Mill Creek, the bed rock where reached was found to be thirty-four feet below low-water mark in the Ohio, while there was nothing to show that in other portions of the valley the gravel was not still deeper. At Hamilton the bed rock was found to be at least ninety-one feet below the bottom of the Ohio River, showing that there is a deeply buried channel through Mill Creek Valley from Cincinnati to Hamilton; while, according to the inspector, Mr. C. J. Bates, upon building the piers for the great bridge of the Cincinnati Southern Railroad, which crosses the Ohio River near the west end of the city, it was found that the rock bottom was everywhere within a few feet of the low-water mark; thus fully justifying the inference of Prof. James, which can best be given in his own words:

"... Previous to the Glacial period a barrier of land extended from Price Hill on the north to the mouth of the Licking River on the south, preventing the westward flow of the Ohio, and forcing it north and northwest along the channels of Mill Creek and Duck Creek. These met at Ludlow Grove (near Cummingsville) and together continued north to Hamilton. Here entered the Great Miami, and the united streams continued in great volume southward to the present channel of the Ohio, at Lawrenceburg.

"At the coming on of the Glacial period a tongue of ice projecting down the valley from the north and surrounding the Cincinnati Island, as we may call that high land now covered with

* See Map II.

suburban homes, forced the water of the Ohio southward, over the watershed of the Licking, possibly into what is now the Kentucky River gorge. This course was pursued for an indefinite period; but, when the ice had retired, the river returned to its own channel near Cincinnati. Finding, however, its outlet to the north choked by *débris* of the glacier, and the former barrier of land between Price Hill and the mouth of the Licking lowered or cut away, it followed the line of drainage it holds at the present time.

"If the eye of savage man gazed upon the site of Cincinnati before the age of ice, he beheld a vastly different scene from what he would behold now. Standing on the highest point of Mount Auburn [Walnut Hills], he looked south over a deep, rocky gorge, through which rolled the mighty Ohio. On the west was the rocky shore of Price Hill extending in an unbroken line north and south to Kentucky. The Licking River entered as a tributary here. On the east was another waste of water rolling its dark tide northward, and joining the western branch beyond the hills of Clifton. No broad expanse of valley nor of rolling plain lay beneath him; no city was there, teeming with life and humming with industry; no railroad trains were panting and puffing, holding their way toward sites of unknown towns. But the water swiftly, with sullen roar re-echoing from cliff to cliff, pursued its journey toward its unknown grave. No steamer plowed its waters, but dugout or canoe probably carried primitive man from camp to camp or shore to shore. Where once the imaginary savage stood are now palatial mansions. Where once the waters spread their turbid tide is now a busy city of four hundred thousand people. The water which was once cleft only by the prow of frail canoe is now a highway for many floating palaces. Where once the stream pursued its northward course, the iron horse carries thousands daily to and from their homes in the wide and fertile Mill Creek Valley. Never would all this have been had not the Glacial period wrought its wondrous change. But the ice filled the valley and forced the river from its course. When permitted to return, the ancient channel was so filled with *débris* that a new one must be cut out, leaving the old one to be utilized by man as a way for his iron servant and as a place whereon to build his cities."*

An inspection of the general map (Map I) will show that this ancient deflection of the Ohio by way of Hamilton is in analogy with the course of the river in many other places, as at Beaver, Pa., and below Marietta, Ohio, and that Prof. James's discovery of the buried channel, showing the ancient deflection by way of

* Journal of the Cincinnati Society of Natural History, July-October, 1888, pp. 100, 101.

Hamilton, adds greatly to the significance of the ice obstruction at that point, for it extends the distance of it about fifty miles, and the distance covered by the ice beyond the original river bed twenty miles.

While every attempt to calculate the chronology of the Glacial period is necessarily but approximate, still we can get from certain data a pretty good idea of the relative periods of time occupied by different stages of the advance and retreat of the ice. It is clear that the obstruction of the Ohio near Cincinnati continued during the whole time occupied by the advance of the ice from Hamilton to its farthest point, ten miles southwest of Cincinnati—that is, during the advance of the ice front over a space of about thirty miles and until its retreat to Cincinnati again. The only statement approaching to definiteness which we are warranted in making concerning the rate of this advance is that it was probably the slowest which we should assign to any part of the movement of the great continental ice-sheet; for, being near the extreme point of extension, the equilibrium of forces must have been very nearly established, and the momentum of the glacier from the north was constantly diminished at the front by the increased rapidity with which a more genial climate was melting the ice. So to speak, the glacier was here getting upon doubtful territory and had carefully to consider every forward step, until finally, having reached the height of the Kentucky hills, the balance was turned, and the retreat began. It is altogether probable that this close balancing of forces resulted in an exceptionally slow movement from Hamilton to Cincinnati, causing the glacier to occupy many centuries, or even thousands of years, in that part of the march.

Something of a measure of this time is perhaps to be found in the erosion of the cross-cut from Cincinnati to the mouth of the Great Miami, which must have begun as soon as the obstruction of the valley near Hamilton first occurred. The length of this new channel of erosion is from twelve to fifteen miles; but how much of the work had been previously done by the small streams formed by the local drainage it is difficult now to calculate. Many such questions remain to reward the labors of local investigators. The general impression which I have received from a study of the facts is that a period of several thousand years may have been occupied by the ice-front in its advance from Hamilton to the farthest point in Kentucky and its subsequent retreat to the north side of the river.

But it is not to be supposed that this period was by any means one of dull uniformity in the history of that region, for upon the first formation of the dam at the bend of the old river at Hamilton, raising the water to the height of the rock obstruction across

the present gorge of the Ohio just below Cincinnati, the river would at once begin the process of cutting down its new channel. A waterfall of far larger proportions than Niagara must have been at once developed in the lower portion of this short cut, near the junction with the Great Miami, which would steadily wear back toward the old channel at Cincinnati, when, if the ice had not reached so far, the water level above the dam would be speedily lowered, but only to be raised again at a later time when the advancing ice reached its farthest extent and obstructed the newer channel. It is altogether probable, however, that this new channel below Cincinnati had not been lowered to its full extent before the maximum advance of the ice. If this were the case the final retreat of the ice across the river would leave a rocky barrier below Cincinnati, such as to maintain the water for a while at a level much higher than that maintained at the present time. There are some deposits up the river indicating that this was the case, as, for instance, some in Teazes Valley extending from the Kanawha River to Huntington. By reference to the first map it will be perceived that this valley is less than seven hundred feet above tide, but it is covered with several feet of very fine sediment, distributed evenly over the bottom of the valley, which must have been deposited in still water during the later stages of the Glacial period.

A glance at the first map will also show some other most interesting problems of change in drainage systems caused by the Glacial period which have not been adequately studied; for example, it will be noticed that a stream rising near Madison, Ind., pursues a very singular course with reference to the contour lines. This is the Muscatatuck River, which rises within less than a mile of the Ohio River and four hundred feet above it; but instead of following the strike of the strata, as it naturally would, around to Louisville, it cuts across a broad north-and-south valley of erosion to join the East Branch of the White River, when both together, continuing on in a westerly course, follow a gorge several hundred feet deep through the highest portion of the State till they unite with the West Branch of the White River to reach the Ohio through the Wabash. It is extremely difficult to explain the course of this stream, except by some such process of reasoning as has been adopted with respect to the Ohio below Cincinnati. The projection of the tongue of ice which extended below Madison deflected the drainage of a considerable region through a partially formed pass across the elevated plateau to the west, while the morainic deposits about the farthest extension of the ice lobe permanently obstructed the channels in that direction, so that upon the withdrawal of the ice the Muscatatuck still continued to run into the Ohio by way of the Wabash.

As has been said, the first announcement of the Cincinnati ice dam was thought to give a natural and sufficient explanation for certain high-level gravel terraces occurring in the upper Ohio Valley. Subsequent investigations have brought to light other considerations which must more or less modify the first conclusions. It still remains true, however, that the ice dam accounts most naturally for many of the slack-water deposits which occur in the valley of the upper Ohio and its tributaries, while there are many areas which are yet but inadequately explored, but which promise important light upon the problem when the facts are all obtained. At the same time it appears that some of the terraces in the Alleghany and Monongahela Rivers are slightly higher than the obstruction at Cincinnati, compelling the advocates of the ice-dam theory to suppose some very probable changes of level since the deposition of the terraces which were at first supposed by Prof. Lesley to be so completely explained by it.

But more important is the bearing of recent discoveries upon the extent to which glacial gravels accumulated in the gorge of the upper Ohio and Alleghany Rivers, as shown in the section in the lower right-hand corner of Map. I. All along the Alleghany and Ohio Rivers there are remnants of gravel accumulations, from fifty to sixty feet deep, resting upon rock shelves about three hundred feet above the present rock bottom of the Ohio. There is now little reason to doubt that during the Glacial period the floods of water which poured into the Alleghany and the Ohio from all their northern tributaries brought along silt, gravel, and bowlders enough to fill up this rocky gorge with great rapidity, down as far probably as Wheeling. As the Alleghany River received glacial floods and glacial *débris* in great quantities, while the Monongahela did not receive any, it will be seen that the Monongahela must have been dammed by both the silt and the water which came down the Alleghany.

Instances in which the water of a tributary is dammed by that of the main stream will occur to any one upon a little reflection. Whenever one large tributary perceptibly rises, it raises the water level of the main stream as well above as below the junction, while a large rise in the main stream may temporarily reverse the current in a tributary. The Columbia River, for example, in Oregon, is subject to very extensive floods at seasons of the year when the Willamette is comparatively low. At such times a current sets up stream past the city of Portland. I remember, also, hearing, when a boy, the story of a June freshet on the Poultney River, in Vermont, caused by a succession of thundershowers about its head waters. The rise in the lower part of the stream amounted to thirty or forty feet. The thing which fixed itself most deeply in my mind was that a milldam upon Hub-

bardton Creek, which was not affected by the showers, was carried up stream by the water which set back from the river. Thus it is easy to see that the glacial floods which poured into the Ohio from its northern tributaries would, during their continuance, produce slack water in its southern tributaries.

A more permanent class of dams is produced when a superabundant amount of earthy *débris* is contributed by one tributary of a stream. It is thus that the Chippewa River, in Wisconsin, has brought down an excessive amount of sand and gravel into the Mississippi, where, owing to the gentler gradient and the slower current in the larger valley, a delta has been pushed out across the Mississippi, ponding back the water so as to form the enlargement known as Lake Pepin. Dr. George M. Dawson describes a more striking instance in one of the principal tributaries of the Fraser in British Columbia, where Dead Man's Creek joins the Thompson. Here a sufficient amount of gravel has been brought down to silt up the main stream to a depth of four hundred and fifty feet, forming Kamloop's Lake, which is eighteen miles long and two miles wide. It is thus that the glacial silts coming into the channel of the Ohio from its northern tributaries have assisted the Cincinnati ice dam in the work that was laid upon it.

On the other hand, it is clear that the Cincinnati ice dam must in turn have assisted greatly in the silting process already referred to; for, as far up the Ohio as slack water was produced by the obstruction at Cincinnati, the deposition of the finer silt must have been greatly facilitated by it. At the same time the deposition of gravel near the mouth of the streams joining the Ohio above Cincinnati, and the obstruction offered by the rock strata, which have since been worn out in the new channel below Cincinnati, combined to relieve the ice gorge there from the supposed incredible hydraulic pressure which some have thought to be fatal to the hypothesis.

In conclusion, it may be said with a fair degree of confidence that the theory of the Cincinnati ice dam still "holds water," though the obstruction itself disappeared many thousand years ago. One may readily admit that some things were at first attributed to the dam which were the result of other causes. But fresh considerations have given increased interest to the theory, so that altogether it remains one of the most striking of all the episodes connected with geologic history, and it is all the more dramatic because of its probable connection with human history. There is, therefore, ample justification for the language of Prof. Claypole, in his paper upon the subject, read before the Geological Society of Edinburgh in 1887, and printed in the Transactions of that year.

Having described the desolation sometimes produced in Switzerland by the bursting of glacial lakes, he remarks that to a still greater extent the "period of conflict between the ice and the river must have been a terrible time for the lower Ohio Valley and its inhabitants. At times the river was dry, and at others bank-full and overflowing. The frost of winter, by lessening the supply, and the ice-tongue by forming a dam, combined to hold back the water. The sun of summer, by melting the dam, and the pressure of the accumulated water, by bursting it, combined to let off all at once the whole of the retained store. Terrible floods of water and ice, laden with stones, gravel, and sand, must have poured down the river and have swept away everything in their path—trees, animals, and man, if present.

"How many years or ages this conflict between the lake and the dam continued it is quite impossible to say, but the quantity of wreckage found in the valley of the lower Ohio, and even in that of the Mississippi, below their point of junction, is sufficient to convince us that it was no short time. 'The Age of Great Floods' formed a striking episode in the story of 'The Retreat of the Ice.' Long afterward must the valley have borne the marks of these disastrous torrents, far surpassing in intensity anything now known on the earth. The great flood of 1884, when the ice-laden water slowly rose seventy-one feet above low-water mark, will long be remembered by Cincinnati and its inhabitants. But that flood, terrible as it was, sinks into insignificance beside the furious torrent caused by the sudden even though partial breach of an ice dam hundreds of feet in height, and the discharge of a body of water held behind it, and forming a lake of twenty thousand square miles in extent.

"To the human dwellers in the Ohio Valley—for we have reason to believe that the valley was in that day tenanted by man—these floods must have proved disastrous in the extreme. It is scarcely likely that they were often forecast. The whole population of the bottom lands must have been repeatedly swept away; and it is far from being unlikely that in these and other similar catastrophes in different parts of the world, which characterized certain stages in the Glacial era, will be found the far-off basis on which rest those traditions of a flood that are found among all savage nations, especially in the north temperate zone."

MR. W. H. DINES, an English meteorologist, is inclined to believe, from observations and experiments made with his new anemometer, that a gust seldom maintains its full power for more than one or two seconds; and that the extreme velocity occurs in lines which are roughly parallel to the direction of the wind.

THE EYE AS AN OPTICAL INSTRUMENT.

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I HAVE often wondered whether the statement, occasionally made by physicists, that the human eye is not a perfect optical instrument, is an expression of human vanity or of an imperfect knowledge of the anatomy of the eye and the physiology of vision; and I have come to the conclusion that the latter is the more reasonable theory. The approach to perfection in modern telescopes and microscopes is wonderful indeed; but as physiologists have advanced the knowledge of vision, the so-called imperfections of the eye have been steadily disappearing; and even now there is much to learn. Viewed merely as an optical instrument, an apparatus contained in a globe less than an inch in diameter, in which is produced an image practically perfect in form and color, which can be accurately adjusted almost instantly for every distance from five inches to infinity, is movable in every direction, has an area for the detection of the most minute details and at the same time a sufficient appreciation of large objects, is double, but the images in either eye exactly coinciding, enables us to see all shades of color, estimate distance, solidity, and to some extent the consistence of objects, the normal human eye may well be called perfect. The more, indeed, the eye is studied in detail, the more thoroughly does one appreciate its perfection as an optical apparatus.

Were it not for a slight projection of the cornea (the transparent covering in front) the eye would have nearly the form of a perfect globe a small fraction less than an inch in diameter. It lies in a soft bed of fat, is held in place by little muscles and a ligament which is so lubricated that its movements take place with the minimum of friction. It is protected by an overhanging bony arch and the eyelids, the eyelashes keeping away dust, and the eyebrows directing away the sweat. Situated thus in the orbit, the eyes may be moved to the extent of about forty-five degrees; but beyond this it is necessary to move the head.

The accuracy of vision depends primarily upon the formation of a perfect image upon the retina, which is a membrane, sensitive to light, connected with the optic nerve. That such an image is actually formed has been demonstrated by an instrument, the ophthalmoscope, which enables us to look into the eye and see the image itself. Although the image is inverted, the brain takes no cognizance of this, and every object is appreciated in its actual

position. The image is formed in the eye in the way in which an image is produced and thrown on a screen by a magic lantern.

When a ray of light passes obliquely from the air through glass, water or other transparent media, it is bent, or refracted, and the angle at which it is bent is called the index of refraction. In passing to the retina, the rays of light pass through the cornea, a watery liquid (the aqueous humor) surrounding the lens, the crystalline lens, and a gelatinous liquid (the vitreous humor) filling the posterior two thirds of the globe, all of which have the same index of refraction. This provides that a ray of light, having once passed through the cornea, is not refracted in passing through the other transparent media, except by the curvatures of the crystalline, which is a double-convex lens situated just behind the pupil. The rays of light are not reflected within the eye itself, for the opaque parts of the globe are lined with a black membrane (the choroid), as the tube of a microscope is blackened for a similar purpose. Practically, the bending of the rays of light is produced by the curved surface of the cornea and

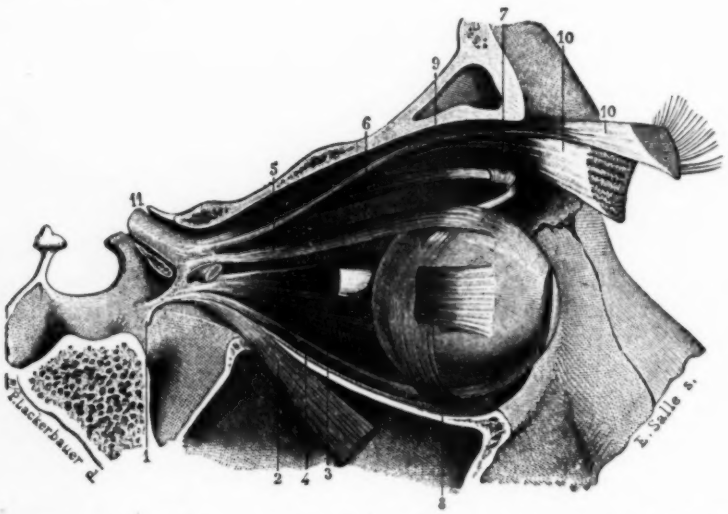


FIG. 1.—This figure gives a general view of the eyeball, the outer wall of the orbit being removed: 1, tendon of origin of three of the muscles of the eyeball; 2, the external straight muscle divided and turned down so as to expose the lower straight muscle; 3, 4, 5, 6, 7, 8, muscles moving the eyeball; 9, 10, 10, muscle which raises the upper eyelid; 11, optic nerve. (After Sappey.)

the two curved surfaces of the double-convex crystalline lens. These three curved surfaces bring the rays from an object to a focus exactly at the retina in a normal eye. When, however, the eye is too long, the focus is in front of the retina unless, in near vision, the object be brought very near the eye, and the person is near-sighted. For ordinary vision, such persons must wear prop-

erly adjusted concave glasses to carry the focus farther back. When the eye is too short, the focus is behind the retina, and the person is far-sighted and must wear convex glasses. The first condition is called myopia, and the second, hypermetropia; but in most persons who are obliged to wear convex glasses in ad-

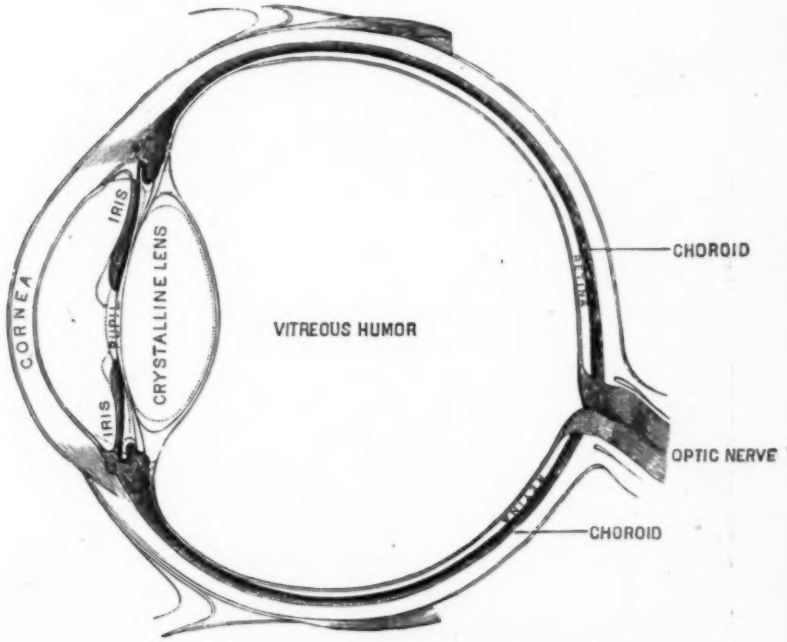


FIG. 2.—DIAGRAMMATIC SECTION OF THE HUMAN EYE.

vanced life, the crystalline lens has become flattened and inelastic, the diameter of the eye being unaltered. This condition is called presbyopia, which means a defect in vision due to old age.

One of the wonderful things about the eye is the mechanism by which a perfect image is formed. What is called the area of distinct vision is a depression in the yellow spot of the retina, which is probably not more than a thirty-sixth of an inch in diameter. It is with this little spot that we examine minute details of objects. If we receive the rays of light from an object upon a double-convex lens and throw them upon a screen in a darkened room, the image of the object appears upon the screen; but in order to render this image even moderately distinct it is necessary to carefully adjust the lens, or the combination of lenses, to a certain distance, which is different for lenses of different curvatures. In the human eye the adjustment is most accurately made, almost instantaneously, for any desired distance, not by changing the distance between the crystalline lens and the retina, but by changing the curvature of the crystalline lens itself. The way in

which this is done has been known only within the last few years. The lens is elastic, and in a quiescent, or what is called an indolent condition, is compressed between the two layers of the ligament which holds it in place. In this condition, when the rays from distant objects are practically parallel as they strike the eye, the lens is adjusted for infinite distance. When, however, we examine a near object, by the action of a little muscle within the eyeball the ligament is relaxed and the elastic lens becomes more convex. This action is called accommodation, and is volun-

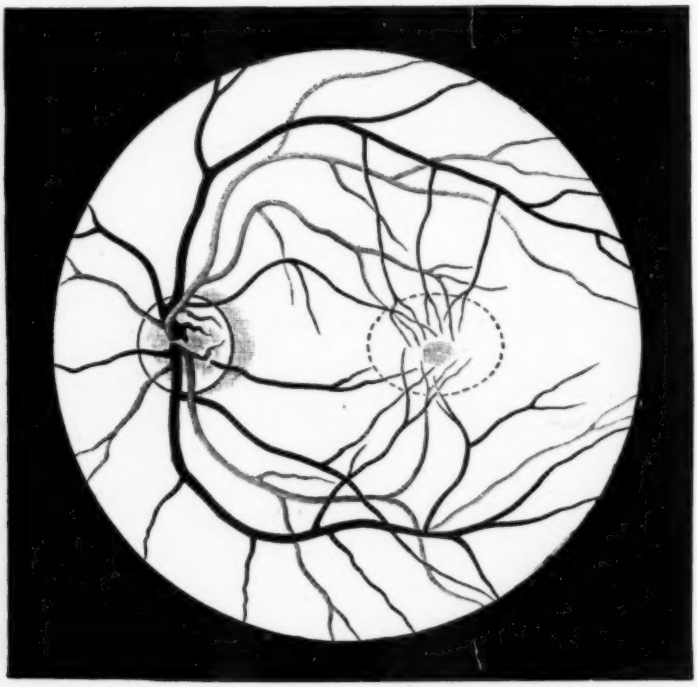


FIG. 3.—VISUAL PORTION OF THE RETINA AS SEEN BY THE OPHTHALMOSCOPE; magnified about seven and a half diameters, showing the blood-vessels branching from the point of entrance of the optic nerve, and the yellow spot surrounded by the dotted oval. (After Loring.)

tary, though usually automatic. The fact that it is voluntary is illustrated by the very simple experiment of looking at a distant object through a gauze placed a few feet from the eye. When we see the distant object distinctly, we do not see the gauze; but by an effort we can distinctly see the meshes of the gauze, and then the object becomes indistinct. In some old persons the lens not only becomes flattened, but it loses a great part of its elasticity and the power of accommodation is nearly lost.

The changes in the curvatures of the lens in accommodation have been actually measured. The lens itself is only about a third

of an inch in diameter and its central portion is only a fourth of an inch thick. Adjusted for infinite distance, the front curvature has a radius of about four tenths of an inch, while for near objects the radius is only about three tenths of an inch. A curious experiment is looking at a minute object through a pinhole in a bit of paper or cardboard, when the object appears highly magnified. This is because the nearer the object is to the eye, the larger it appears. The shortest normal distance of distinct vision is about five inches; but in looking through a pinhole we can see at a distance of less than an inch, using a very small part of the central portion of the crystalline lens. Accommodation for very near objects is assisted, also, by contraction of a little band of fibers in the iris, about a fiftieth of an inch in width, immediately surrounding the pupil.

The most wonderful thing about the formation of a perfect image upon the retina is the mechanism of correction for form

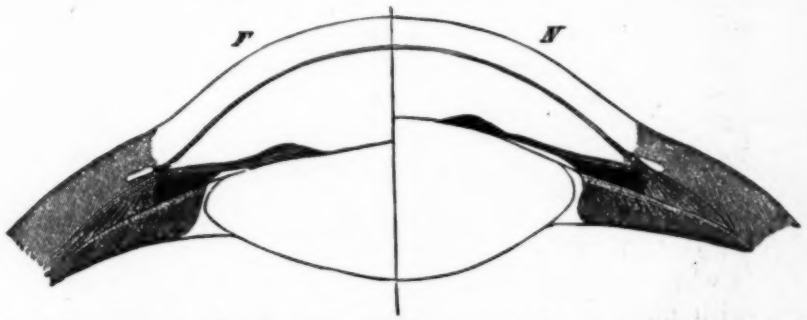


FIG. 4.—SECTION OF THE LENS SHOWING THE MECHANISM OF ACCOMMODATION. The left side of the figure (F) shows the lens adapted to vision at infinite distances. The right side of the figure (N) shows the lens adapted to the vision of near objects. (After Fick.)

and color. In grinding lenses for the microscope, for example, it is mechanically easy to make a very small convex lens with perfectly regular curvatures — that is, each curvature being a portion of a perfect sphere; but in such a lens the focus of the central portion is longer than that of the parts near the edge; and when an object is in focus for the center it is out of focus for the periphery. This is a fatal objection to the use of uncorrected lenses of high power; but in microscopes it is corrected by combinations of lenses, reducing the magnifying power, however, about one half. This is not all. When white light passes through a simple lens it is decomposed into the colors of the spectrum. This is called dispersion, and it surrounds the object with a fringe of colors. The dispersion by concave lenses is exactly the opposite of the dispersion by convex lenses, so that this may be corrected by a combination of the two; but when this is done with lenses made of precisely the same material, the magnifying power

is lost. Newton supposed that it was an impossibility to construct a lens corrected for color which would magnify objects; but since the discovery (in 1753 and 1757) of different kinds of glass having the same refractive power but widely different dispersive powers, perfect lenses have been possible.

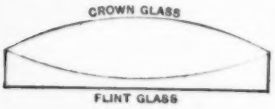


FIG. 5.—ACHROMATIC LENS.

In the human eye, a practically perfect image, with no alteration in color, is produced by a mechanism which human ingenuity can not imitate. There is a slight error in the cornea, which is corrected by an opposite error in the crystalline lens; the iris plays the part of the diaphragm of optical instruments and shuts off the light from the borders of the crystalline lens, where the error is greatest, particularly in near vision; the curvatures of the lens are not perfectly spherical, but are such that the form of objects is not distorted; and while such curvatures are theoretically calculable, their construction is practically impossible, as experience has shown; different layers of the crystalline lens have different dispersive powers; and thus a practically perfect image, with no appreciable decomposition of white light, is formed on the retina.

Another wonderful thing about the eye, which adapts it most beautifully to our requirements, is the division of the sensitive parts of the retina into a very small area for distinct vision, which we use for reading, for example, and a large surrounding area in which vision is indistinct. If we saw with equal distinctness with all parts of the retina, the vision of minute objects would be confused and imperfect. As it is, the area of distinct vision is very small, probably less than one thirty-sixth of an inch in diameter. In this area, the distance between the separate sensitive elements is not more than one thirty-five-hundredth of an inch; while, if we pass from this only eight degrees, the distance is increased a hundred times. Still, in looking at any one object in the center of distinct vision, the imperfect forms of surrounding objects are appreciated, warning us, perhaps, of the approach of danger.

The mechanism of distinct and indistinct vision has been understood only since 1876. The sensitive parts of the retina are little rods and cones forming a layer by themselves. In 1876, Boll discovered that in frogs kept in the dark the rods of the retina were colored a dark purple; but on exposure to light the color faded, becoming first yellow and then white. Since that time, physiologists have been carefully investigating visual purple and visual yellow. Just outside the layer of rods and cones are the dark cells which render the greatest part of the interior of the eye almost black. In the dark, these cells send little filaments be-

tween the rods and discharge a liquid which colors the rods alone. When the rods are thus colored, the eye is extremely sensitive, so that a bright light is dazzling and painful and obscures distinct vision. This is the reason why we can not see distinctly when we come suddenly from the dark into a full light. In a few seconds, however, the color is bleached to a yellow and the difficulty passes away. When, on the other hand, we pass from a bright light into the dark, the retina has lost its sensibility from disappearance of the visual purple, and we can not see at all until the purple is reproduced, as it is in the absence of light. This difference is not due to dilatation of the pupil in the dark and contraction under the influence of light, as is popularly supposed, for a person does not see better in the dark when the pupil has been fully dilated by belladonna.

In the little area of distinct vision there is never any visual purple. This area we always use with sufficient light for minute details of objects, making then the greatest use of the mechanism of accommodation. The area outside of this is used for indistinct vision, and as the color is then yellow instead of purple, it is only moderately sensitive. To express the conditions in a few words, the minute area for distinct vision is used by day, and the area for indistinct vision, with its visual purple, is used by night.

A very curious condition is what is known as night-blindness. Sometimes, in long tropical voyages, sailors become affected with total blindness at night, while vision in the daytime is perfect. The glare of the sun in the long days bleaches the visual purple so completely that it can not be restored in a single night, and the area of indistinct vision becomes insensible. This trouble is purely local and is remedied by rest of the eye. If one eye be protected by a bandage during the day, this eye will be restored sufficiently for the next night's watch, while the unprotected eye is as bad as ever. Snow-blindness in the arctic regions is due to the same cause.

We receive the impression of a single object, although there are two images—one in either eye; but it is necessary that the images be made upon corresponding points in the two retinæ. If the angle of vision in one eye be deviated even to a slight degree by pressing on one globe with the finger, we see two images. One can appreciate how exactly these points must correspond when it is remembered that two rays of light appear as one only when the distance between them is one thirty-five-hundredth of an inch.

In either eye there is a blind spot, and this is at the point of penetration of the optic nerve; but, inasmuch as this spot is in the area of indistinct vision, and is so situated—a little within the line of distinct vision—that an impression is never made on both blind spots by the same object, this blindness is never appreciable,

and the spot can be detected only by the most careful investigation.

Not the least of the wonders of the eye are connected with the appreciation of images made upon the retina by certain parts of the brain. It is literally true that a person may see and yet not perceive. It has happened, in certain injuries of the brain, that a person sees and reads the words in a book and yet does not perceive their significance. This is called word-blindness. In a certain portion of the brain is a part which enables us to recognize the fact that we see an object; yet this object conveys no idea. There are two of these so-called centers of vision, one on either side, and their action is partly crossed. When the center is destroyed on one side, the inner half of one eye and the outer half of the other eye are blinded. Farther back in the brain, however, is a center which enables us to perceive or understand what is seen. When this center is destroyed we see objects and may avoid obstacles in walking, but persons, words, etc., are not recognized. This center exists only on the left side of the brain.

An impression, however short, made upon the retina is perceived. The letters on a printed page are distinctly seen when illuminated by an electric spark, the duration of which is only forty billionths of a second; but the impression remains much longer. Anything in motion appears to us in a way quite different from the single impression that we should have from an electric spark. In a picture representing an animal in motion, as it appears in an instantaneous photograph, the positions seems absurd and like nothing we have ever seen. In looking at a horse in action, the impressions made by the different position of the animal run into each other, and art should represent as nearly as possible the sum or average of these impressions. It is also true that impressions are diffused in the retina beyond the points upon which they are directly received. This is called irradiation; and the impression is diffused farther for white or light-colored than for black or dark objects. It is well known that a white square looks considerably larger than a dark square of exactly the same size; or the hands in white gloves look larger than in black gloves.

I have described, in as simple a way as possible, some wonderful things about the eye ascertained and explained by modern investigations; but there are many interesting facts ascertained which space has not permitted me to discuss, and there still remains much that is not yet understood. The whole question of the appreciation of colors and of color-blindness is still wrapped in mystery. We know that some persons can not distinguish between certain colors, but the reason of this is obscure. Perfect sight can exist only when the eye is perfect. The form and color of objects may be distorted so that an inaccurate

image is formed upon the retina, and this image, however imperfect it may be, is what is perceived by the brain. In hearing the case is different. The waves of sound, if they be conducted to the internal ear, and if the nerve of hearing, with its terminations, be normal, can not be modified in course of transmission. Sounds are always appreciated at their exact value, except as regards intensity. Enough has been said about the eye, I think, to show that it is perfectly adapted to all requirements, and whatever defects it may seem to have, viewed as an optical instrument, render it more useful to us than if these apparent defects did not exist.

THE KINDERGARTEN A NATURAL SYSTEM OF EDUCATION.

By JAMES L. HUGHES,
PUBLIC-SCHOOL INSPECTOR, TORONTO.

THE kindergarten is a natural system of education, because it recognizes the natural laws of human growth, and supplies the necessary conditions to stimulate the special powers of each individual child. It recognizes the fact that each child has an individuality peculiarly its own, and that the greatest evil of school life in the past has been the dwarfing of individual power. No two children are alike, no two should be alike. All should be in unison by having the same desire to live for the right, but the powers of each and the methods of using them should be his own. The mightiest, holiest part of each individual is the quality or power in which he differs from all others. Schools generally manufacture men and women "to pattern." Whatever the ability, general or special, possessed by the different pupils of a class, they have all been expected to rise or fall to the same dead level. Usually the level has been very *dead*. The kindergarten is founded on the broad principle that the Creator had a special purpose in giving life to each child, and that the school should aid the child in becoming as nearly as possible what God meant him to be when he first let him enter the world. The kindergarten insists on the proper control of each child, because uncontrolled spontaneity commonly leads to anarchy and unbridled evil, but it never allows power to be destroyed by controlling it.

The kindergarten values the child more than the knowledge to be communicated to it or acquired by it. It values knowledge highly, but it places its highest estimate on the child, who has power to give the only real value to knowledge. It knows that the development of the child increases his capacity for gathering and using knowledge. It believes that the child's powers should

grow forever, that they grow most rapidly in early years, and that true growth in childhood is the only basis for the highest development of maturity. Therefore it makes the child and his universal tendencies and activities the chief study of the educator. The highest function of the teacher is not to select the knowledge most appropriate for children, or to decide the best plans for fixing it in their minds; his greatest study is the child and the ways in which he educates himself in those most prolific years before he goes to school. Some teachers claim that the teacher's duty is to teach the child how to "go." The child was set going long before he went to school. He was kept going before he went to school more rapidly than he ever goes after that time. Others say, the teacher's duty is to start the child to *grow*. How he had been growing before he went to school! How he grew physically; how his mind unfolded and defined itself; how his spiritual nature recognized the Creator in the wondrous material creation, and reached out to the mysteries of the unknown! He was ever going before he went to school, and growing because he was going. The reason he stops growing rapidly as soon as he goes to school is that his teachers interfere with his going. They stop his going altogether during school hours, and the reason he does not stop growing altogether physically, intellectually, and spiritually is that he is fortunately not kept in school all the time. How full of gratitude we should be for the fact that the blighting processes of the schoolroom last but six hours of five days in each week! We should be even more grateful when we remember that the school hours may become the most productive of the day in real growth. This is a part of the revelation which the kindergarten bears to all teachers who study it with sympathetic spirit. There is no good reason why the child's development should be checked after it goes to school. It should continue to improve with accelerated speed throughout life. Teachers will do vastly better than they do now when they keep up, after the child goes to school, the rate of advancement attained before he goes to school. They can never hope to do this until they study and understand the fundamental principles that underlie the motives of children, and guide them in the infinitely varied activities of their childish work and play. All their activities are in harmony with a divine purpose in the accomplishment of their fullest development. Man can best learn how to teach from the greatest teacher. His power and the unequaled success of his plans can be learned by the careful and continuous study of childhood. The teaching profession has been learning this fact from the kindergarten. There are several organized agencies already in existence for recording and comparing the characteristics, the tendencies, the habits, the activities, the capabilities, and the pro-

gressive development of children in different parts of the world. The new era has begun.

In the kindergarten the child's spontaneity is respected. He is not guided too much. He is allowed to work out, with the material given him, the plans, the designs, the problems, that arise in his own mind. The kindergarten dictates plans, designs, or problems to him only so far as may be necessary to help his mind to recognize new conceptions. He never has a lesson in which he is a follower or an imitator all the time. The idea that he should produce a result similar to his neighbor's is never presented to him. He is trained to depend on his own mind for the plan or design, and for its execution. Nature's plan before the child goes to school is to let him find his own problems. His greatest mental power is the ability to recognize in the material world by which he is surrounded the new things he has not seen before and the new problems he does not understand. If he has the privilege of growing up among the beauties of natural life, if the trees and flowers, and birds and butterflies, and bees and crickets, are his companions, if he has sand and stones and sticks for his playthings, there are few of the problems of science and material philosophy that do not present themselves to his mind. He solves thousands of them unaided, and brings those that are too deep for him to his mother or father, or most sympathetic older friend. These problems are not forced upon his mind by any external agency, they lie all around his path awaiting recognition by his mind. The recognition comes under such conditions exactly at the right moment, when the mind is ready to deal with the problem. No wonder that, under such conditions, knowledge is acquired and mental power defined and developed so rapidly. But when the child goes to school all these conditions are absolutely reversed. The teacher finds the problems and brings them to the child. Worse than this, the problems are those that suggest themselves to the teacher's mind and not the child's. Such problems can not be appropriate for the child. The problems suitable for one child can not be the best for other children at the same time. No mind but the child's own can decide the character of the problems suited to its present condition of development. Mind-growth can be dwarfed in no other way so completely as by the presentation of unsuitable problems. Loss of interest and loss of power, negation instead of positivity, indifference in place of aggressive wonderment, must follow when the child is forced to deal with problems that are not in harmony with his mental development.

One of the greatest improvements in school-teaching will be the placing of the children in such conditions that they may find their own problems. In the kindergarten this is the foundation

principle of mental growth. Self-activity does not mean activity in working out the directions of a teacher or any other superior mind; it means the revelation or execution of the conceptions of the child himself. The child's work should be self-expression, not imitation, not mere responsive action in accord with the suggestion of a teacher. "The children are not interested in study, and most of them need to be forced to learn; so it would be worse than folly to expect them to find problems for themselves." So says the teacher who has had no true inspiration, no clear enlightenment. My dear friend, it is quite true that the children are not interested in your problems. It is true, moreover, that the few who gratify you and their parents by paying attention to your problems and learning your lessons usually make weak men, lacking in originality and force. Every head boy who leaves school with a load of prizes in his arms and a load of knowledge in his head, and then becomes a respectable nonentity, is an unripe, falling apple to set educational Newtons thinking.

The pupils do rebel against your problems; but they do not rebel against the problems of Nature before they go to school. Wake up! There are apples falling all around you. The greatest development in school processes during the next twenty-five years will be the introduction into the schoolroom of appropriate material, calculated to stimulate the investigative and executive powers of children, and thus continue the natural educational processes that led to such rapid and definite growth before school life began.

By reversing Nature's plan, and bringing the problems to children, instead of allowing them to find them for themselves, teachers prevent the development of the power to recognize new problems. This is the most important of all intellectual powers. The solution of new problems is a simple matter when we can clearly recognize them. The ability to see the things yet unseen must precede the knowledge of the things yet unknown. The power to see new problems should grow in strength and clearness more rapidly than any other mental power. It can not grow unless it has the opportunity for exercise. The greatest teacher is the one who presents to the child the best opportunities for the recognition of new problems by his own mind, and the most perfect facilities for expressing or representing his new conceptions in material form. The wonderment of the child in regard to the material world should become much more than a mental stimulus; it should ultimately become our highest, broadest, keenest spiritual insight. We are ever in the midst of new spiritual problems that we fail to recognize, because our wonder power was not allowed to act up to its natural limit.

In the kindergarten, knowledge is made clear by the self-

activity of the child. All growth of human power is based on the self-activity of the individual to be developed. No thought is ever definite until it has been consciously lived out or wrought out. The kindergarten makes use of self-expression in the child to define the thought already in its mind, and to reveal new thought. There is no other way by which thought can be clearly revealed and defined. Self-activity on the part of the child secures four very important results: it enables the teacher to be sure that the child is paying attention to its work, it reveals the nature of the child's own conceptions, it is an accurate test of the clearness of the thought received from the instruction of the teacher, and it is the most productive incentive to originality.

In the kindergarten, knowledge is applied as it is gained. The old plan of learning definitions or tables, or the names or powers of letters, or the theoretical principles of any science as a preparation for practical work to be done in geometry, algebra, arithmetic, reading, or science, was not in harmony with natural laws of growth. It is unnatural to value knowledge of any kind for itself alone. Knowledge has no value except as it is used; and an assumed value based on any other foundation must be fictitious and misleading. The child should not be interested in knowledge that it is not required to use in some way. When it becomes conscious of a lack of knowledge that is essential to the accomplishment of any definite purpose in its mind, it needs no artificial stimulus to make it give active and persistent attention. The consciousness of necessity should precede the effort to acquire. The kindergarten leads the child to define knowledge by using it, and uses knowledge as soon as it is acquired.

The kindergarten trains the executive powers of children. Formerly only their receptive powers were cultivated. They were made receptacles for knowledge communicated by the teacher, and their powers of receiving knowledge independently were developed. When teachers had accomplished the two purposes of storing the minds of their pupils and training their powers of observation, so as to qualify them for gaining knowledge readily and accurately themselves, they were satisfied. Better teachers were soon convinced that the accumulation of knowledge by even the most perfect methods was not the true aim of education, and gradually the reflective power received attention as well as the receptive powers. The lesson that the kindergarten has for us is that the best training of the receptive and reflective powers is practically valueless unless the executive powers are trained too. It will not do to leave the training of the executive powers to the circumstances of life outside of school. The receptive powers receive a great deal of good training outside of school; so do the reflective powers; so, too, do the executive powers. There is

no reason for leaving the development of the executive powers to the conditions outside of school that does not apply with equal force to the culture of the receptive and reflective powers. Such a course would do away with schools altogether. There are two reasons that render the training of the executive powers of children absolutely essential in a complete education: First, the receptive and reflective powers are really useful to the individual and humanity only when they are made productive by executive ability; and, second, the training of the executive powers is the only way by which the receptive and reflective powers can be thoroughly cultivated. Nature's sequence is: Receive, reflect, use. The first two steps must be imperfect without the third. The kindergarten always completes the ascent; it never destroys the unity of the trinity.

The kindergarten makes children creative; or it is better to say that it preserves and utilizes their creative powers. Men and women were not intended to be mere imitators or servile followers of other men and women. They should be independent, original, creative. Man can not be creative as God is creative, but the divine in each human being gives him power to be and do what others have never been or done. There is something for each of us to discover and reveal; something for each to produce; something for each to add to the helpful agencies that serve to make man happier; something that will aid in the realization of the highest hopes of the heart of humanity. The kindergarten aims from the first to develop the truly productive more than the reproductive tendencies and talents of the child. It makes children not merely submissive and responsive, but suggestive, inventive, creative. The schools and universities will learn to do so in due time.

The discipline of the kindergarten is natural. It is based on love and executed by love. There is no heart whose feelings are not purified and ennobled by the consciousness of the love of another heart; no mind that is not aroused and stimulated to grander effort by the full sympathy of another mind. The young heart yearns for the mother-love, and there is no other who could make so perfect a teacher as the mother of the child to be taught, if her education and her time were sufficient for the work. There will come a time when noble mothers will train great daughters and sons for humanity to a much greater extent than they do now. As women more clearly realize their powers and their responsibilities, it will be impossible to satisfy them with the society customs of semi-civilization. The social instinct has been terribly degraded. The period of its ennobling is at hand, when social unity shall in no sense be formalism. The kindergarten emphasizes the need of mother-love as an educational force. It does

not propose that the kindergarten shall be a substitute for the mother; but it tries to provide for the little ones a beautiful home, where they may enjoy the sympathetic affection of a true woman's heart, and have at the same time the advantages of the culture of a trained educator. It is only when the child's nature opens to the light that its complete life grows; it is only when the child's heart is happy that its mind is free. In the true kindergarten no woman can find a place whose heart is not young, whose life is not pure, and whose aims are not unselfish. Love is the greatest controlling force and the greatest intellectual stimulus.

PLEASURES OF THE TELESCOPE.

By GARRETT P. SERVISS.

I.—THE SELECTION AND TESTING OF A GLASS.

IF the pure and elevated pleasure to be derived from the possession and use of a good telescope of three, four, five, or six inches aperture were generally known, I am certain that no instrument of science would be more commonly found in the homes of intelligent people. The writer, when a boy, discovered unexpected powers in a pocket telescope not more than fourteen inches long when extended, and magnifying ten or twelve times. It became his dream, which was afterward realized, to possess a more powerful telescope, a real astronomical glass, with which he could see the beauties of the double stars, the craters of the moon, the spots on the sun, the belts and satellites of Jupiter, the rings of Saturn, the extraordinary shapes of the nebulæ, the crowds of stars in the Milky Way, and the great stellar clusters. And now he would do what he can to persuade others, who perhaps are not aware how near at hand it lies, to look for themselves into the wonder-world of the astronomers.

There is only one way in which you can be sure of getting a good telescope. First, decide how large a glass you are to have, then go to a maker of established reputation, fix upon the price you are willing to pay—remembering that good work is never cheap—and finally see that the instrument furnished to you answers the proper tests for a telescope of its size. There are telescopes and telescopes. Occasionally a rare combination of perfect homogeneity in the material, complete harmony between the two kinds of glass of which the objective is composed, and lens surfaces whose curves are absolutely right, produces a telescope whose owner would part with his last dollar sooner than with it. Such treasures of the lens-maker's art can not, perhaps, be com-

manded at will, yet they are turned out with increasing frequency, and the best artists are generally able, at all times, to approximate so closely to perfection that any shortcoming may be disregarded.

In what is said above I refer, of course, to the refracting telescope, which is the form of instrument that I should recommend to all amateurs in preference to the reflector. But, before proceeding further, it may be well to recall briefly the principal

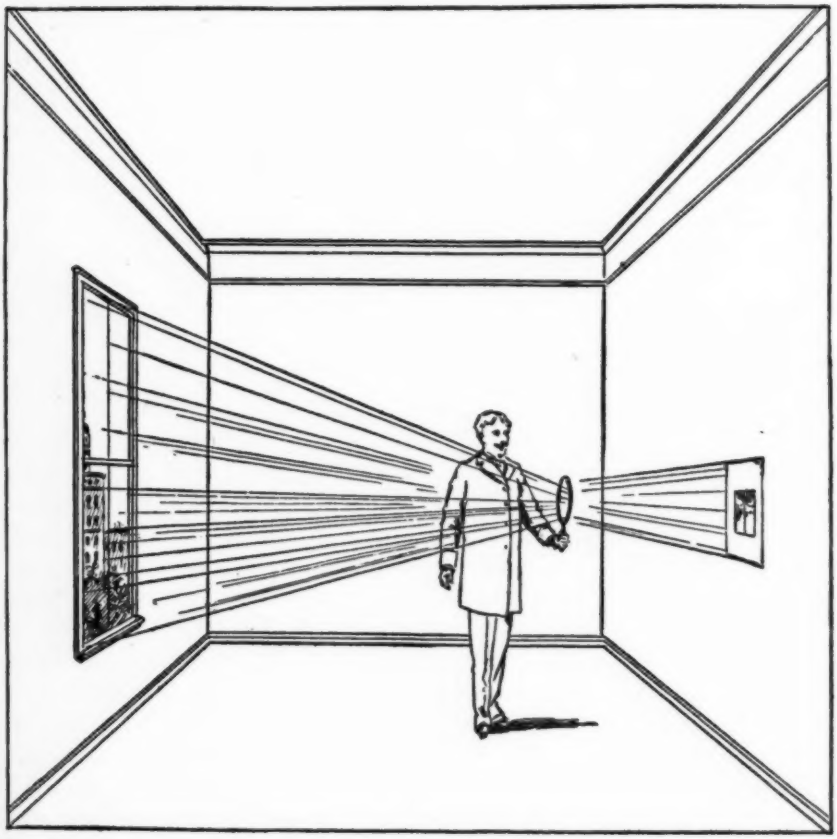


FIG. 1.—IMAGE AT THE FOCUS OF A LENS.

points of difference between these two kinds of telescopes. The purpose of a telescope of either description is, first, to form an image of the object looked at by concentrating the rays of light proceeding from that object at a focus. The refractor achieves this by means of a carefully shaped lens, called the object glass, or objective. The reflector, on the other hand, forms the image at the focus of a concave mirror.

A very pretty little experiment, which illustrates these two methods of forming an optical image, and, by way of corollary,

illustrates the essential difference between refracting and reflecting telescopes, may be performed by any one who possesses a reading glass and a magnifying hand mirror. In a room that is not too brightly illuminated pin a sheet of white paper on the wall opposite to a window that, by preference, should face the north, or away from the position of the sun. Taking first the reading glass, hold it between the window and the wall parallel to the sheet of paper, and a foot or more distant from the latter. By moving it to and fro a little you will be able to find a distance, corresponding to the focal length of the lens, at which a picture of the window is formed on the paper. This picture, or image, will be upside down, because the rays of light cross at the focus. By moving the glass a little closer to the wall you will cause the picture of the window to become indistinct, while a beautiful image of the houses, trees, or other objects of the outdoor world beyond, will be formed upon the paper. We thus learn that the distance of the image from the lens varies with the distance of the object whose image is formed. In precisely a similar manner an image is formed at the focus of the object glass of a refracting telescope.

Take next your magnifying or concave mirror, and detaching the sheet of paper from the wall, hold it nearly in front of the mirror between the latter and the window. When you have adjusted the distance to the focal length of the mirror, you will see an image of the window projected upon the paper, and by varying the distance, as before, you will be able to produce, at will, pictures of nearer or more remote objects. It is in this way that images are formed at the focus of the mirror of a reflecting telescope.

Now, you will have observed that the chief apparent difference between these two methods of forming an image of distant objects is that in the first case the rays of light, passing through the transparent lens, are brought to a focus on the side opposite to that where the real object is, while in the second case the rays, being reflected from the brilliant surface of the opaque mirror, come to a focus on the same side as that on which the object itself is. From this follows the most striking difference in the method of using refracting and reflecting telescopes. In the refractor the observer looks toward the object; in the reflector he looks away from it. Sir William Herschel made his great discoveries with his back to the sky. He used reflecting telescopes. This principle, again, can be readily illustrated by means of our simple experiment with a reading glass and a magnifying mirror. Hold the reading glass between the eye and a distant object with one hand, and with the other hand place a smaller lens such as a pocket magnifier, near the eye, and in line with the reading glass.

Move the two carefully until they are at a distance apart equal to the sum of the focal lengths of the lenses, and you will see a magnified image of the distant object. In other words, you have constructed a simple refracting telescope. Then take the magnifying mirror, and, turning your back to the object to be looked at, use the small lens as before—that is to say, hold it between your eye and the mirror, so that its distance from the latter is equal to the sum of the focal lengths of the mirror and the lens,

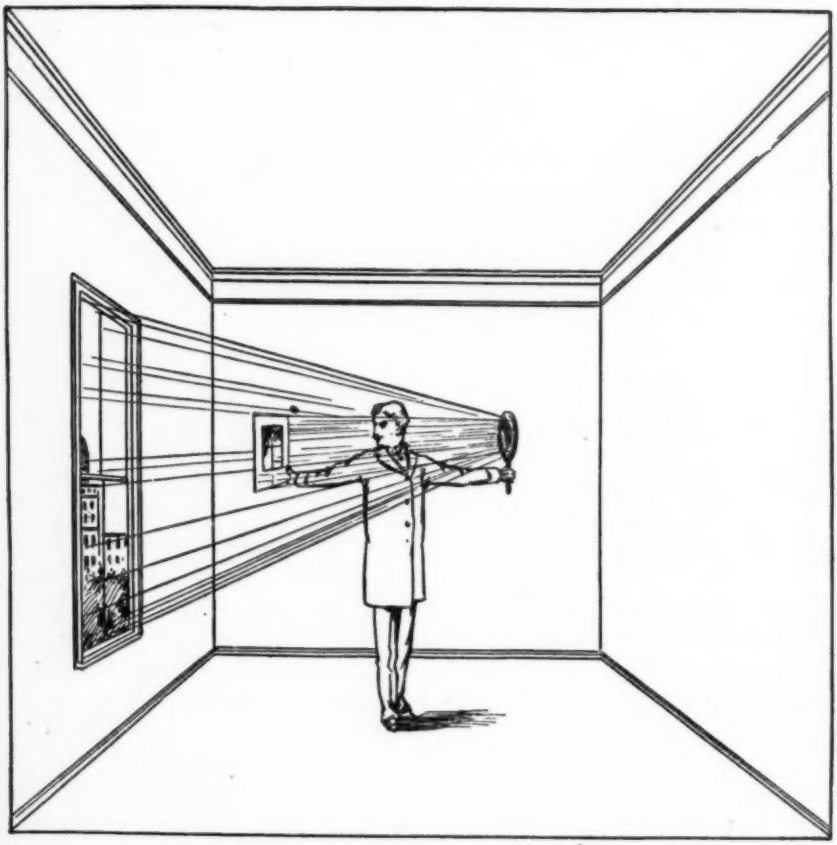


FIG. 2.—IMAGE AT THE FOCUS OF A CONCAVE MIRROR.

and you will see again a magnified image of the distant object. This time it is a reflecting telescope that you hold in your hands.

The magnification of the image reminds us of the second purpose which is subserved by a telescope. A telescope, whether refracting or reflecting, consists of two essential parts, the first being a lens, or a mirror, to form an image, and the second a microscope, called an eyepiece, to magnify the image. The same eyepieces will serve for either the reflector or the refractor. But in order that the magnification may be done with effect, and

cerve to reveal what could not be seen without it, the image itself must be as nearly perfect as possible; this requires that every ray of light that forms the image shall be brought to a point in the image precisely corresponding to that from which it emanates in the real object. In reflectors this is effected by giving a parabolic form to the concave surface of the mirror. In refractors there is a twofold difficulty to be overcome. In the first place, a lens with spherical surfaces does not bend all the rays that pass through it to a focus at precisely the same distance. The rays that pass near the outer edge of the lens have a shorter focus than that of the rays which pass near the center of the lens; this is called spherical aberration. A similar phenomenon occurs with a concave mirror whose surface is spherical. In that case, as we have seen, the difficulty is overcome by giving the mirror a parabolic instead of a spherical form. In an analogous way the spherical aberration of a lens can be corrected by altering its curves, but the second difficulty that arises with a lens is not so easily disposed of: this is what is called chromatic aberration. It is due to the fact that the rays belonging to different parts of the spectrum have different degrees of refrangibility, or, in other words, that they come to a focus at different distances from the lens; and this is independent of the form of the lens. The blue rays come to a focus first, then the yellow, and finally the red. It results from this scattering of the spectral rays along the axis of the lens that there is no single and exact focus where all meet, and that the image of a star, for instance, formed by an ordinary lens, even if the spherical aberration has been corrected, appears blurred and discolored. There is no such difficulty with a mirror, because there is in that case no refraction of the light, and consequently no splitting up of the elements of the spectrum.

In order to get around the obstacle formed by chromatic aberration it is necessary to make the object glass of a refractor consist of two lenses, each composed of a different kind of glass. One of the most interesting facts in the history of the telescope is that Sir Isaac Newton could see no hope that chromatic aberration would be overcome, and accordingly turned his attention to the improvement of the reflecting telescope and devised a form of that instrument which still goes under his name. And even after Chester More Hall in 1729, and John Dollond in 1757, had shown that chromatic aberration could be nearly eliminated by the combination of a flint-glass lens with one of crown glass, William Herschel, who began his observations in 1774, devoted his skill entirely to the making of reflectors, seeing no prospect of much advance in the power of refractors.

A refracting telescope which has been freed from the effects of chromatic aberration is called achromatic. The principle upon

which its construction depends is that by combining lenses of different dispersive power the dispersion of the spectral colors can be corrected while the convergence of the rays of light toward a focus is not destroyed. Flint glass effects a greater dispersion than crown glass nearly in the ratio of three to two. The chromatic combination consists of a convex lens of crown backed by a concave, or plano-concave, lens of flint. When these two lenses are made of focal lengths which are directly proportional to their dispersions, they give a practically colorless image at their common focus. The skill of the telescope-maker and the excellence of his work depend upon his selection of the glasses to be combined and his manipulation of the curves of the lenses.

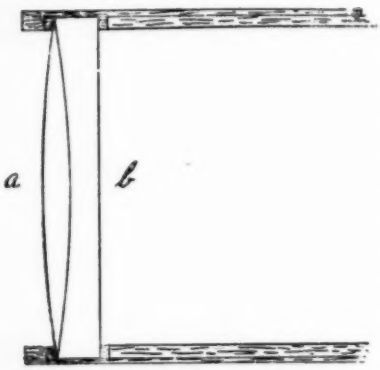


FIG. 3.—ACHROMATIC OBJECT GLASS. *a*, crown glass; *b*, flint glass.

Now, the reader may ask, "Since reflectors require no correction for color dispersion, while that correction is only approximately effected by the combination of two kinds of lenses and two kinds of glass in a refractor, why is not the reflector preferable to the refractor?"

The answer is, that the refractor gives more light and better definition. It is superior in the first respect because a lens transmits more light than a mirror reflects. Prof. Young has remarked that about eighty-two per cent of the light reaches the eye in a good refractor, while "in a Newtonian reflector, in average condition, the percentage seldom exceeds fifty per cent, and more frequently is lower than higher." The superiority of the refractor in regard to definition arises from the fact that any distortion at the surface of a mirror affects the direction of a ray of light three time as much as the same distortion would do at the surface of a lens. And this applies equally both to permanent errors of curvature and to temporary distortions produced by strains and by inequality of temperature. The perfect achromatism of a reflector is, of course, a great advantage, but the chromatic aberration of refractors is now so well corrected that their inferiority in that respect may be disregarded. It must be admitted that reflectors are cheaper and easier to make, but, on the other hand, they require more care, and their mirrors frequently need resilvering, while an object glass with reasonable care never gets seriously out of order, and will last for many a lifetime.

Enough has now, perhaps, been said about the respective

properties of object glasses and mirrors, but a word should be added concerning eyepieces. Without a good eyepiece the best telescope will not perform well. The simplest of all eyepieces is a single double-convex lens. With such a lens the magnifying power of the telescope is measured by the ratio of the focal length of the objective to that of the eye lens. Suppose the first is sixty inches and the latter half an inch; then the magnifying power will be a hundred and twenty diameters—i. e., the disk of a planet, for instance, will be enlarged a hundred and twenty times along each diameter, and its area will be enlarged the square of a hundred and twenty, or fourteen thousand four hundred times. But in reckoning magnifying power, diameter, not area, is always considered. For practical use an eyepiece composed of an ordinary single lens is seldom advantageous, because good definition can only be obtained in the center of the field. Lenses made according to special formulæ, however, and called solid eyepieces, give excellent results, and for high powers are often to be preferred to any other. The eyepieces usually furnished with telescopes are, in their essential principles, compound microscopes, and they are of two descriptions, "positive" and "negative." The former generally goes under the name of its inventor, Ramsden, and the latter is named after the great Dutch astronomer, Huygens. The Huygens eyepiece consists of two plano-convex lenses whose focal

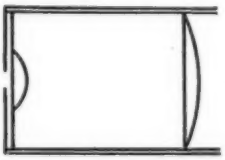


FIG. 4.—NEGATIVE EYEPIECE.

FIG. 5.—POSITIVE EYEPIECE.

lengths are in the ratio of three to one. The smaller lens is placed next to the eye. Both lenses have their convex surfaces toward the object glass, and their distance apart is equal to half the sum of their focal lengths. In this kind of eyepiece the image is formed between the two lenses, and if the work is properly done such an eyepiece is achromatic. It is therefore generally preferred for mere seeing purposes. In the Ramsden eyepiece two plano-convex lenses are also used, but they are of equal focal length, are placed at a distance apart equal to two thirds of the focal length of either, and have their convex sides facing one another. With such an eyepiece the image viewed is beyond the farther or field lens instead of between the two lenses, and as this fact renders it easier to adjust wires or lines for measuring purposes in the focus of the eyepiece, the Ramsden construction is used when a micrometer is to be employed. In order to ascertain

the magnifying power which an eyepiece gives when applied to a telescope it is necessary to know the equivalent, or combined, focal length of the two lenses. Two simple rules, easily remembered, supply the means of ascertaining this. The equivalent focal length of a negative or Huygens eyepiece is equal to half the focal length of the larger or field lens. The equivalent focal length of a positive or Ramsden eyepiece is equal to three fourths of the focal length of either of the lenses. Having ascertained the equivalent focal length of the eyepiece, it is only necessary to divide it into the focal length of the object glass (or mirror) in order to know the magnifying power of your telescope when that particular eyepiece is in use.

A first-class object glass (or mirror) will bear a magnifying power of one hundred to the inch of aperture when the air is in good condition—that is, if you are looking at stars. If you are viewing the moon, or a planet, better results will always be obtained with lower powers—say fifty to the inch at the most. And under ordinary atmospheric conditions a power of from fifty to seventy-five to the inch is far better for stars than a higher power. With a five-inch telescope that would mean from two hundred and fifty to three hundred and seventy-five diameters, and such powers should only be applied for the sake of separating very close double stars. As a general rule, the lowest power that will distinctly show what you desire to see gives the best results. The experienced observer never uses as high powers as the beginner does. The number of eyepieces purchased with a telescope should never be less than three—a very low power—say ten to the inch; a very high power, seventy-five or one hundred to the inch, for occasional use; and a medium power—say forty to the inch—for general use. If you can afford it, get a full battery of eyepieces—six or eight, or a dozen—for experience shows that different objects require different powers in order to be best seen, and, moreover, a slight change of power is frequently a great relief to the eye.

There is one other thing of great importance to be considered in purchasing a telescope—the mounting. If your glass is not well mounted on a steady and easily managed stand, you might better have spent your money for something more useful. I have endured hours of torment while trying to see stars through a telescope that was shivering in the wind and dancing to every motion of the bystanders, to say nothing of the wriggling contortions caused by the application of my own fingers to the focussing screw. The best of all stands is a solid iron pillar firmly fastened into a brick or stone pier, sunk at least four feet in the ground, and surmounted by a well-made equatorial bearing whose polar axis has been carefully placed in the meridian. It can be readily

protected from the weather by means of a wooden hood or a rubber sheet, while the tube of the telescope may be kept indoors, being carried out and placed on its bearing only when observations are to be made. With such a mounting you can laugh at the observatories with their cumbersome domes, for the best of all observatories is the open air. But if you dislike the labor of carrying and adjusting the tube every time it is used, and are both fond of and able to procure luxuries, then, after all, perhaps, you had better have the observatory, dome, draughts and all.

The next best thing in the way of a mounting is a portable tripod stand. This may be furnished either with an equatorial bearing for the telescope, or an altazimuth arrangement which permits both up-and-down and horizontal motions. The latter is cheaper than the equatorial and proportionately inferior in usefulness and convenience. The essential principle of the equatorial bearing is motion about two axes placed at right angles to one another. When the polar axis is in the meridian, and inclined at an angle equal to the latitude of the place, the telescope can be moved about the two axes in such a way as to point to any quarter of the sky, and the motion of a star, arising from the earth's rotation, can be followed hour after hour without disturbing the instrument. When thus mounted, the telescope may be driven by clockwork, or by hand with the aid of a screw geared to a handle carrying a universal joint.

And now for testing the telescope. It has already been remarked that the excellence of a telescope depends upon the perfection of the image formed at the focus of the objective. In what follows I have only a refractor in mind, although the same principle would apply to a reflector. With a little practice anybody who has a correct eye can form a fair judgment of the excellence of a telescopic image. Suppose we have our telescope steadily mounted out of doors (if you value your peace of mind you will not try to use a telescope pointed out of a window, especially in winter), and suppose we begin our observations with the pole star, employing a magnifying power of sixty or seventy to the inch. Our first object is to see if the optician has given us a good glass. If the air is not reasonably steady we had better postpone our experiment to another night, because we shall find that the star as seen in the telescope flickers and "boils," and behaves in so extraordinary a fashion that there is no more definition in the image than there is steadiness in a bluebottle buzzing on a window pane. But if the night is a fine one the star image will be quiescent, and then we may note the following particulars: The real image is a minute bright disk, about one second of arc in diameter if we are using a four-and-a-half or five-inch telescope, and surrounded by one very thin ring of light, and the

fragments, so to speak, of one or possibly two similar rings a little farther from the disk, and visible, perhaps, only by glimpses. These "diffraction rings" arise from the undulatory nature of light, and their distance apart as well as the diameter of the central disk depend upon the length of the waves of light. If the telescope is a really good one, and both object glass and eyepiece are properly adjusted, the disk will be perfectly round, slightly softer at the edge, but otherwise equally bright throughout; and the ring or rings surrounding it will be exactly concentric, and not brighter on one side than on another. Even if our telescope were only two inches or two inches and a half in aperture we should at once notice a little bluish star, the mere ghost of a star in a small telescope, hovering near the pole star. It is the celebrated "companion," but we shall see it again when we have more time to study it. Now let us put the star out of focus by turning the focusing screw. Suppose we turn it in such a way that the eyepiece moves slightly outside the focus, or away from the object glass. Very beautiful phenomena immediately begin to make their appearance. A slight motion outward causes the little disk to expand perceptibly, and just as this expansion commences, a bright-red point appears at the precise center of the disk. But, the outward motion continuing, this red center disappears, and is replaced by a blue center, which gradually expands into a sort of flare over the middle of the disk. The disk itself has in the mean time enlarged into a series of concentric bright rings, graduated in luminosity with beautiful precision from center toward circumference. The outermost ring is considerably brighter, however, than it would be if the same gradation applied to it as applies to the inner rings, and it is surrounded, moreover, on its outer edge by a slight flare which tends to increase its apparent width. Next let us return to the focus and then move the eyepiece gradually inside the focal point or plane. Once more the star disk expands into a series of circles, and, if we except the color phenomena noticed outside the focus, these circles are precisely like those seen before in arrangement, in size, and in brightness. If they were not the same, we should pronounce the telescope to be imperfect. There is one other difference, however, besides the absence of the blue central flare, and that is a faint reddish edging around the outer ring when the expansion inside the focus is not carried very far. Upon continuing to move the eyepiece inside or outside the focus we observe that the system of rings becomes larger, while the rings themselves rapidly increase in number, becoming at the same time individually thinner and fainter.

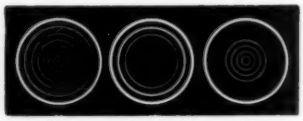
FIG. 6. — THE STAR IMAGE.

By studying the appearance of the star disk when in focus and

of the rings when out of focus on either side, an experienced eye can readily detect any fault that a telescope may have. The amateur, of course, can only learn to do this by considerable practice. Any glaring and serious fault, however, will easily make itself manifest. Suppose, for example, we observe that the image of a star instead of being perfectly round is oblong, and that a similar defect appears in the form of the rings when the eyepiece is put out of focus. We know at once that something is wrong; but the trouble may lie either in the object glass, in the eyepiece, in the eye of the observer himself, or in the adjustment of the lenses in the tube. A careful examination of the image and the out-of-focus circles will enable us to determine with which of these sources of error we have to deal. If the star image when in focus has a sort of wing on one side, and if the rings out of focus expand eccentrically, appearing wider and larger on one side than on the other, being at the same time brightest on the least expanded side, then the object glass is probably not at right angles to the axis of the tube and requires readjustment. That part of the object glass on the side where the rings appear most expanded and faintest needs to be pushed slightly inward. This can be effected by means of counterscrews placed for that purpose in or around the cell. But if, after we have got the object glass properly squared to the axis of the tube or the line of sight, the image and the ring system in and out of focus still appear oblong, the fault of astigmatism must exist either in the objective, the eyepiece, or the eye. The chances are very great that it is the eye itself that is at fault. We may be certain of this if we find, on turning the head so as to look into the telescope with the eye in different positions, that the oblong image turns with the head of the observer, keeping its major axis continually in the same relative position with respect to the eye. The remedy then is to consult an oculist and get a pair of cylindrical eyeglasses. If the oblong image does not turn round with the eye, but does turn when the eyepiece is twisted round, then the astigmatism is in the latter. If, finally, it does not follow either the eye or the eyepiece, it is the objective that is at fault.

But instead of being oblong, the image and the rings may be misshapen in some other way. If they are three-cornered, it is probable that the object glass is subjected to undue pressure in its cell. This, if the telescope has been brought out on a cool night from a warm room, may arise from the unequal contraction of the metal work and the glass as they cool off. In fact, no good star image can be got while a telescope is assuming the temperature of the surrounding atmosphere. Even the air inclosed in the tube is capable of making much trouble until its temperature has sunk to the level of that outside. Half an hour at least is re-

quired for a telescope to adjust itself to out-of-door temperature, except in the summer time, and it is better to allow an hour or two for such adjustment in cold weather. Any irregularity in the shape of the rings which persists after the lenses have been accurately adjusted and the telescope has properly cooled may be ascribed to imperfections, such as veins or spots of unequal density in the glass forming the objective.



1 2 3

FIG. 7.—THE OUT-OF-FOCUS RINGS. 1, Correct figure; 2 and 3, spherical aberration.

The spherical aberration of an object glass may be undercorrected or overcorrected. In the former case the central rings inside the focus will appear faint and the outer ones unduly strong, while outside the focus the central rings will be too bright and the outer ones too feeble. But if the aberration is overcorrected the central rings will be overbright inside the focus and abnormally faint outside the focus.

Assuming that we have a telescope in which no obvious fault is discernible, the next thing is to test its powers in actual work. In what is to follow I shall endeavor to describe some of the principal objects in the heavens from which the amateur observer may expect to derive pleasure and instruction, and which may at the same time serve as tests of the excellence of his telescope.

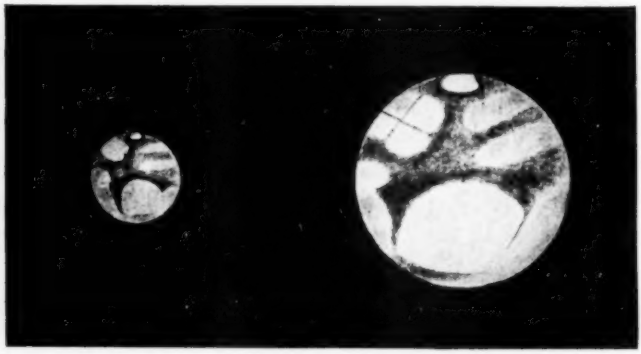


FIG. 8.—TWO VIEWS OF MARS IN 1892. The smaller with a three and three eighths inch telescope; the larger with a nine inch.

No one should be deterred or discouraged in the study of celestial objects by the apparent insignificance of his means of observation. The accompanying pictures of the planet Mars may serve as an indication of the fact that a small telescope is frequently capable of doing work that appears by no means contemptible when placed side by side with that of the greater instruments of the observatories.

SHOULD PROHIBITORY LAWS BE ABOLISHED?

By T. D. CROTHERS, M.D.

MR. APPLETON MORGAN, in the March number of The Popular Science Monthly, affirms that all prohibitory liquor laws should be abolished. Naturally, the reader inquires for what reasons and upon what evidence, and expects to find a grouping of facts that will at least give some support to these claims. If, on the contrary, the author assumes that the reader will credulously accept his confident statements as facts, it is to be supposed that such statements will be in accord with common observation, historical facts, and experience; if they fail in this, and are not sustained by any general examination, it is safe to conclude that the purpose of the paper is not to present the truth, and the author is a partisan, having some other object to accomplish not apparent in his writings.

The magnitude and intensely practical character of the question of prohibitory laws seem to demand some examination of the author's assertions. He begins with this: "The absolute, unqualified, and distinguished failure of all laws for the abolishment of the traffic in liquors is speedily convincing even the most sanguine prohibitionists of the expediency of wiping them from every statute book in the land."

In the failure to refer to authority for this statement the reader must examine for himself. Political records in yearly volumes, and histories of political reform, give no evidence or names of sanguine or other prohibitionists who are convinced of the failure of such laws.

Governors of States where prohibition laws are in force have without exception declared in their favor. Some have suggested modifications and changes from the present form, but all have affirmed their great value in securing better observance of law and order.

In 1889 a canvass was made of the opinions of judges, Congressmen, mayors of cities, superintendents of schools, journalists, manufacturers, postmasters, and others in the State of Maine, asking their opinion of the practical value of the existing prohibitory laws. In one hundred and forty replies only seven expressed any doubt, the others were confident and enthusiastic. Similar canvasses made in Vermont, Rhode Island, Kansas, Iowa, and in States where prohibition had been tried, brought out the same unanimous replies from equally eminent men, who were not in any way identified with the party of prohibition.

These and other systematic inquiries have been published in the New York Voice, a leading prohibition paper, and are cer-

tainly entitled to credence from the fearless, independent character of the replies. Turning to the Brewers' Journal and the Wine and Spirit Circular, which are supposed to represent those opposed to all prohibitory laws, the statements which are presented are of such a startling character, showing the failure of such laws, as to create doubt of their accuracy. The evidence in both of these journals and their reports is so intensely partisan and extreme as statements of alleged facts as to appear unfair and doubtful.

The census reports of 1880 and 1890 show a marked decrease of crime, pauperism, drunkenness, and arrests in all the States where prohibition is in force. No matter how these facts are explained, they do not support the statement that prohibition is a distinguished failure.

The author continues: "These laws never had any adequate or logical reason for existing at all. They have had their origin always and without exception in sparsely settled communities, where personal liberty was so absolute that it became irksome, where liquor was almost unknown, and its use a curiosity, and where the only knowledge of the horrors of intoxication the village possessed was derived from itinerant temperance orators, who dilated upon the terrible consequences of the rum habit to a roomful of tearful old women, none of whom knew the taste of liquor stronger than green tea."

The first sentence of this quotation must be accepted exclusively on faith, for there are no reasons for supposing that the long lists of philosophers, reformers, and leaders who have urged prohibitory laws were stupid, illogical, and unable to realize and reason on a certain line of facts. The rest of the paragraph ignores all early history of the origin of prohibitory legislation. The author has overlooked the fact that prohibitionary laws were enacted in Judea, Egypt, Greece, and Rome long centuries ago; also that Xenophon, Plato, and Aristotle discussed these questions, and Homer and Herodotus declared that "prohibitory laws would save men from becoming beasts." If the author will turn to his copy of Rollin's Ancient History, Montesquieu's Spirit of Laws, and Whewell's Platonic Dialogues, and his Morality and Polity, he will find his assertions out of harmony with the facts.

Along in this connection he asserts that the New England Puritan "no more thought of prohibiting the drinking of liquor than the preaching eight or ten hour sermons." Here again the facts of history are ignored. Laws were passed in Massachusetts, Connecticut, and Rhode Island, as early as 1640, prohibiting the sale of liquor to Indians, negroes, and mulatto slaves, and earlier than this innkeepers were prohibited from selling spirits after nine o'clock at night, and on Sunday, or to drunken men. The

Puritans for over a hundred years were struggling to prohibit the sale of liquor under certain conditions, and colonial and later laws regulating who should sell spirits, and when, and to whom, and under what conditions, would fill a volume. Volumes of sermons preached during this time will show that prohibition was a very serious topic; one of the reasons held was that intoxication was due to direct Satanic influence.

The reiteration that the various statutes against the selling of liquor are not for the general good, and do not come from a demand for protection or public peace, or from cause of necessity, or expediency, or in a community where the evil of the sales is apparent or experienced, and that not a single proposition for the policy of prohibition arises from demand for relief, sound like Rev. Jasper's declarations: "The Sun he do move; the Earth he do stand still."

The admission that "if laws preventing the sale of liquors should be demanded by the users, and purchasers who desired to be relieved of the temptation of buying it, a wise policy might decree the prevailing of the petition," is followed by a statement that "the non-users and non-purchasers who are in the majority, and those who have never suffered, need protection for which they have not asked." Any careful study will show that a large proportion of the most enthusiastic supporters of prohibitory laws are persons who have either suffered personally or in their families, or socially or financially, from the evils of spirits. Very few persons urge an unpopular cause unless from some strong conviction based on an experience that has a personal bearing. While any new movement always attracts a certain class of irregulars and camp followers, they soon drop out, and seldom continue attached to it very long. The rank and file who are honest in their theories and proposals for relief keep on until their ideals are realized, or some new way gives new form and direction to their efforts.

The earliest liquor law Mr. Morgan could find grew out of some letters appearing in a paper in 1832. At that time there were twenty States in the Union, with a great number and variety of prohibitory laws on their statute books. Many of these States had laws enacted half a century before; even some of the Territories had very stringent laws regulating the liquor traffic. The colony of Georgia for nine years was under a strong prohibitory law passed by the English Parliament in 1735. The early laws prohibiting and restricting the sale of spirits in this country would fill a small-sized volume, even before 1832, and from that time on several volumes would be required to contain them.

The statement that the State of Maine before 1832 was almost

Arcadian in its innocence respecting the use of spirits is remarkable. The laws concerning spirits, local option, license, and prohibition, and the penalties for common drunkards, selling to minors, soldiers, Indians, and drinking on Sunday, and where and when liquors should be sold, passed in 1821–'24 and 1829, give no indications of Arcadian innocence in Maine at that time.

In 1829 the first local option and literal prohibition law was passed in Maine; this was changed from time to time, and finally became the famous Maine law of 1846 and 1851, which exists to-day. In a little volume by Dr. Jewett, published in 1853, appear some harrowing accounts of the crimes and pauperism in Maine springing directly from drunkenness, long before the famous prohibitory law was enacted. Thus there is no doubt that the early settlers of Maine were as much addicted to the so-called vices of drink as any other people.

The author declares that all prohibitory liquor laws are dangerous to the physical, moral, and political health of the community; that (1) "they increase the demand for, while deteriorating the quality of, the supply of liquors." The censuses of 1880 and 1890, and internal revenue reports, indicate a decrease in the sale of spirits in all the States where prohibition exists. The demand and consumption of spirits and beer in adjoining States and cities, not under these laws, give no indications of increased sales of spirits which are or may be consumed in these prohibition sections. Individual opinions to the effect that the demand for spirits has increased are not sustained by statistics from reliable sources. The deterioration in the quality of the liquors is found, from numerous analyses by chemists of the various State Boards of Health, to be principally from water. The drugs used for color and flavor are generally innocuous in both effect and quantity. The quality of the liquor depends on the kind of alcohol, which is far more likely to be dangerous in the so-called pure liquors than the cheap combinations of the saloon keeper.

This fact has been studied by the leading chemists of France, in several elaborate reports, in which it appears that the poisons of liquors are due to the formation and combinations of different alcohols, that are due to natural changes, and can only be known to the analytical chemist and inferred by the clinician from a study of the observed effects on the consumer. It has been repeatedly stated by authorities that a large part of the cheap liquors sold are new spirits adulterated with water, and made pleasant by flavoring substances. Hence cheap liquors from low places may be far safer as beverages than old, expensive spirits from the cellars and vaults of the most reliable dealers.

(2) The assertion that the law against the use of liquors stimulates to greater violation of the law, and produces an appe-

tite for liquor-drinking where it did not exist before, would be easily verifiable if true; but, upon appeal to the facts of statistical reports of criminal and health boards, there is no evidence to sustain it.

The next assertion (3), that such laws give the visionary and crank class in the community political balance of power, is equally unverifiable. The author's complaint that prohibition laws beget an exaggerated oratory, and an appetite for sweeping statements and the cultivation of false statistics, etc., receives a most practical illustration in his paper. His own sweeping denials and allegations of facts, which are not substantiated by any investigation, are ample proof of the danger of such literature to the credulous and unthinking.

To say that all prohibition laws are worse than useless, that they have not lessened the sale or consumption of liquors; that free spirits and free sale would increase the horror of the drunkard and decrease the horror of liquor; and by making the one a crime and nuisance, the merits of the other would come into prominence, or, in other words, increase the severity of the punishment of the drunkard and make the sale of liquor practically free, sounds very tropical to say the least.

The final reference to statistics showing an increased longevity of the drinkers over the total abstainers, as a fact which appeared in the British Medical Journal, is notoriously untrue and mischievous.

Such are some of the allegations which challenge the author for particulars and specifications, to make good his assertions. As they are presented in a historic form, they are apparently based on defective knowledge and incorrect statements and faulty observations of facts, or the construction of facts, according to some theory or purpose, irrespective of all relations or inferences.

It would seem useless to make any detailed study of statements that are unverifiable even if true, in which no appeal to facts is made, especially statements that will not bear the most casual scrutiny. Reformers and their opponents who battle with each other in a "Donnybrook-fair style," striking in all directions, with the wildest dogmatic assertions, reckless of history, facts, and truth, never advance any cause however meritorious.

If the prohibitionary laws are dangerous and injurious there should be facts and data to prove it clearly, and no arguments based on assumed facts, with crooked deductions and doubtful statements, should ever be urged in its defense.

Leaving Mr. Morgan's strange statements, we turn to some general considerations of the alcoholic evil, and the legislative efforts to check and remove it.

To any one who will examine from the scientific side the vari-

ous questions concerning the drink problem, and the remedies offered, many new facts and conclusions will appear. From this point of view, the accumulation of facts and their comparative accuracy is required, with indifference concerning any possible conclusions they may indicate. Wherever personal feelings and self-interest enter into such inquiry, the value and accuracy of the results are impaired. As in a law court, the question is simply one of *facts* and their *meaning*. Some of the facts may be grouped and studied!

In a general way it may be stated that the physiological action of alcohol on the body is practically unknown. Theories of its value as a food, as a nutrient, and as a force-producer, and its usefulness as a beverage, when examined, are found to be unverifiable or untrue. Evidence of its value in health and in moderation rests on theory and superstition, and is not sustained by appeals to facts.

The question of its value as a medicine is by no means settled. Men eminent in science, and fully competent to decide, express doubt, or deny its value altogether. Leading physicians and teachers of medicine prescribe less and less spirits, and the extent of its use in disease is becoming more limited every year.

The evidence of its value as a beverage is doubtful, to say the least, while the disastrous effects of alcohol can not be questioned, and the accumulated evidence of years brings this fact into increasing prominence.

A historical retrospect of the legal efforts to control and restrict the use of spirits suggests an evolution and growth that has not been considered before. Outside of biblical literature, whose teachings and laws are so often quoted, a remarkable chapter of legal enactments and restrictions can be traced. Beginning with the fragmentary inscriptions found on Egyptian papyri and monuments, and extending to the codes, philosophies, and enactments of the greatest philosophers, rulers, and judges of Grecian and Roman civilization, there is a continuous record of prohibitory laws and restrictions concerning the use of spirits and drunkenness. The laws of the Spartans were far more absolute than any modern enactments, and were also remarkable for the clear comprehension of the nature of spirits and their action on the body. These laws were active for many years, and were highly commended.

English history contains many records of prohibitory, restrictive laws, some of which were very prominent for a time, then fell into disuse. Laws of similar import have followed the path of civilization from the earliest dawn and wherever spirits have been used. They have been urged and defended by the greatest philosophers, teachers, and leaders of civilization.

Prohibitory laws and enactments in this country are a repetition of the reform efforts of centuries ago, only on a higher plane, showing decided evolution and growth. The laws of those early times were based on observation of the ill effects of spirits, and the expediency of checking these evils. The same laws in modern times are founded on moral theories and facts which seem to indicate no other means for relief.

In all times the sanitary evils of drink have been recognized at first only faintly, then in an increasing ratio, down to the present. To-day scientists and sanitarians are beginning to understand the perilous and dangerous influence of alcohol in nearly all conditions of life.

Modern prohibitory laws appear to be founded on mixed theories, and are not clear or harmonious in their workings. The applications of these laws, from the earliest settlements of the country down to the present time, give abundant illustrations of this. In several States prohibitory laws have been on trial for a quarter of a century and more, and have seemed to meet the expectations of their supporters. In others such enactments have been abandoned after a short experiment for various complicating reasons. Political partisanship has been so intimately concerned with these questions that the facts are very obscure.

The assertions and denials of the practical value of prohibitory enactments are equally confusing. The only unbiased authority from the census and internal revenue reports, in the states where these laws are in force, points to a diminishing use of spirits, better social and sanitary conditions, and lessened lawlessness.

Widely different explanations of this fact are urged and defended with great positiveness. High license and local option have their warm defenders and bitter opponents. Their value in different communities rests on the same uncertain and differently explained facts; often their adoption or rejection is mere caprice, political selfishness, and the changing sentiment of the hour.

The theoretical scientific study of spirits and their effects opens up another field that brings a wider conception to the problem. Here the student is confronted with the same evidence of evolution. Theories urged two thousand years ago—that drunkenness was a disease, and that spirits was an exciting cause, in some cases merely exploding a condition which was due to influences more remote and widely varied, or building up a morbid state which will require the narcotism of spirits ever after—have become demonstrable facts of modern times.

The remedies for these are restraint, control, and medical treatment of the victims, by legal enactments prohibitory and coercive. It is also evident that vast ranges of unknown causes and

conditions, which enter into the phenomena of life and living, are the basal factors of drunkenness and inebriety. Remedies—legislative, social, and medical—to be effectual must be founded on some general knowledge of these causes. Such are some of the general facts of the drink problem as seen to-day. Many of them are very significant, and have a meaning which is unmistakable.

The great revolutions of theories concerning alcohol and its physiological action on the body, together with the rapid accumulation of evidence contradicting all previous conceptions of its value as a nutrient, stimulant, and beverage, are conclusive that the facts are not all known. Countries and cities where wine and beer and other alcoholic drinks have been used freely, without question, are invaded by temperance and total abstinence societies. Theories of the value of spirits that have come down unquestioned are being challenged and proof of their truth demanded.

The French National Temperance Society, the Society against the Abuses of Alcohol for the Rhine Provinces, the Belgian Total Abstinence Society, the Netherland Society, the Swiss Society, the Italian Society, the Austrian and Prussian Society, the Norwegian, Russian, Danish, and numerous other societies, are urging total abstinence theories, and denying the value of spirits in the very centers of all spirit-drinking countries. Four international congresses have been held in these countries during the past ten years, in which eminent medical men have presented and defended the total abstinence side of the drink problem.

The real facts, separated from all partisan sensationalism, agree that alcohol is a poison, a paralyzant, and narcotic, and its defenders admit this as true, but only in large and reckless quantities. The question then turns on what quantities are safe or dangerous, and what is the possible amount that can be taken within health limits. This is similar to drawing boundary lines between twilight and darkness, and is obviously impossible with the present limits of our knowledge.

The evidence up to this time from the chemical laboratory, from experiments, from hospital studies, from statistics, and other sources, clearly proves that alcohol is a poison and is positively dangerous to health—in what way, in what conditions, and under what circumstances is yet an open question, in which difference of opinion will exist until more exhaustive experimental studies are made. Text-books for schools and colleges and partisan discussions often contain statements conveying the misleading impression that the facts about alcohol are known, when, in reality, beyond a few general principles, we are profoundly ignorant of its physiological action. The facts concerning its ravages and baneful influence are too common to be called in question,

and the statement that it is the greatest peril to modern civilization has a basis in actual experience.

It appears to be a conclusion, which all scientific and sociological progress is verifying, that a more complete knowledge of alcohol will demand some form of prohibitory laws; whether like those existing at present or not it is impossible now to say. Such laws will not depend on any sentiment or any theory, but will be founded on demonstrated truths, and the necessity for self-preservation. It will not be a question of Maine law, or whether prohibition prohibits, or whether any party or society or public sentiment favors or opposes it. Action will be taken on the same principle that a foul water supply is cleansed or a sanitary nuisance removed. The questions of high or low license, local option, and all the various schemes of partial or complete restriction, with the vast machinery of moral forces that seek relief by the church, the pledge, the prayer, and the temperance society, will be forgotten, and the evil will be dealt with in the summary way in which enlightened communities deal with other ascertained causes of dangerous disease.

While the average citizen may be slow to unlearn and change his views about alcohol, he is ever quick to recognize and provide for dangers that peril his personal interests. Show this man that every place where spirits are sold as a beverage is a "poison center" and every drinker is a suicidal maniac, whose presence is dangerous to the happiness and peace of the community, and he will at once become a practical prohibitionist. This is the direction toward which all temperance agitation is drifting.

Sanitary boards, government commissions, and hospital authorities must gather the facts from very wide sources, and the generalizations from these will supplement and sustain the laboratory and hospital work and point out conclusions that will be real advances in this field. Inebriate asylums (at present obscure and bitterly opposed) will become very important aids in the study of the causes of inebriety. Like prohibitory laws, they will become a recognized necessity when the disease of inebriety and the poison of alcohol are understood.

Beyond all theory and agitation there is another movement of startling significance. Everywhere the moderate and excessive drinking man is looked upon with suspicion. His capacity is doubted, and his weakness is recognized as dangerous in all positions of trust and confidence. Corporations and companies demand employees to be total abstainers. Railroads, manufactories, and even retail liquor dealers of the better class require all workmen to be temperate men. This is extending to all occupations, and the moderate drinker is being crowded out as dangerous and unfit. This movement has no sentiment, but is the result of experi-

ence and the recognition of the danger of the use of alcohol as a beverage. Nothing can be more absolute than these unwritten prohibitory laws which discharge workmen seen in saloons and refuse to employ skilled men because they use spirits in moderation.

To repeal all restrictive and prohibitory laws and open the doors for the free use of rum is to act in opposition to all the facts of observation and experience. On the other hand, to insist that prohibitory laws are the only measures to correct the drink evils, or that high license and local option are equally powerful as remedies, is to assume a knowledge of alcohol and inebriety that has not been attained. The highest wisdom of to-day demands the facts and reasons for the use of alcohol, and why it should be literally and theoretically the cause of so much loss and peril to the race. All hope for the future solution of these questions must come from accurately observed facts and their teachings, and, like the problems of the stars above us, be determined along lines of scientific inquiry.

DAIRY SCHOOLS AND DAIRY PRODUCTS.

By F. W. WOLL,
ASSISTANT PROFESSOR OF AGRICULTURAL CHEMISTRY IN THE UNIVERSITY OF WISCONSIN.

EVERYBODY likes good butter and good cheese, but to a large proportion of our population these very desirable articles of food would come in under the head of luxuries. Perhaps more than ninety per cent of the butter consumed by our people is made on farms or in private dairies; a great deal of it is fit for a king's table, and more and more of this kind of butter is made every year; still, when we consider the number of small towns in the United States and the quality of the mass of butter which every week is brought to the corner grocery store in each one of these places, there to be exchanged for three cent calico or twenty-five-cent coffee, it is evident that a large proportion of our butter is unqualifiedly bad. As for much of the cheese sold, the trouble lies in another direction—less in faulty methods of manufacture than in a flooding of the market with an immature, indigestible, sole-leather product, which some of us may know from the dining rooms of second and third class hotels.

While we, therefore, may find fault with a large share of the dairy products sold in the United States, we can not wonder very much that such is the case. Not until of late years has thorough, systematic instruction in their manufacture been offered anywhere in this country. The fundamental principles of the

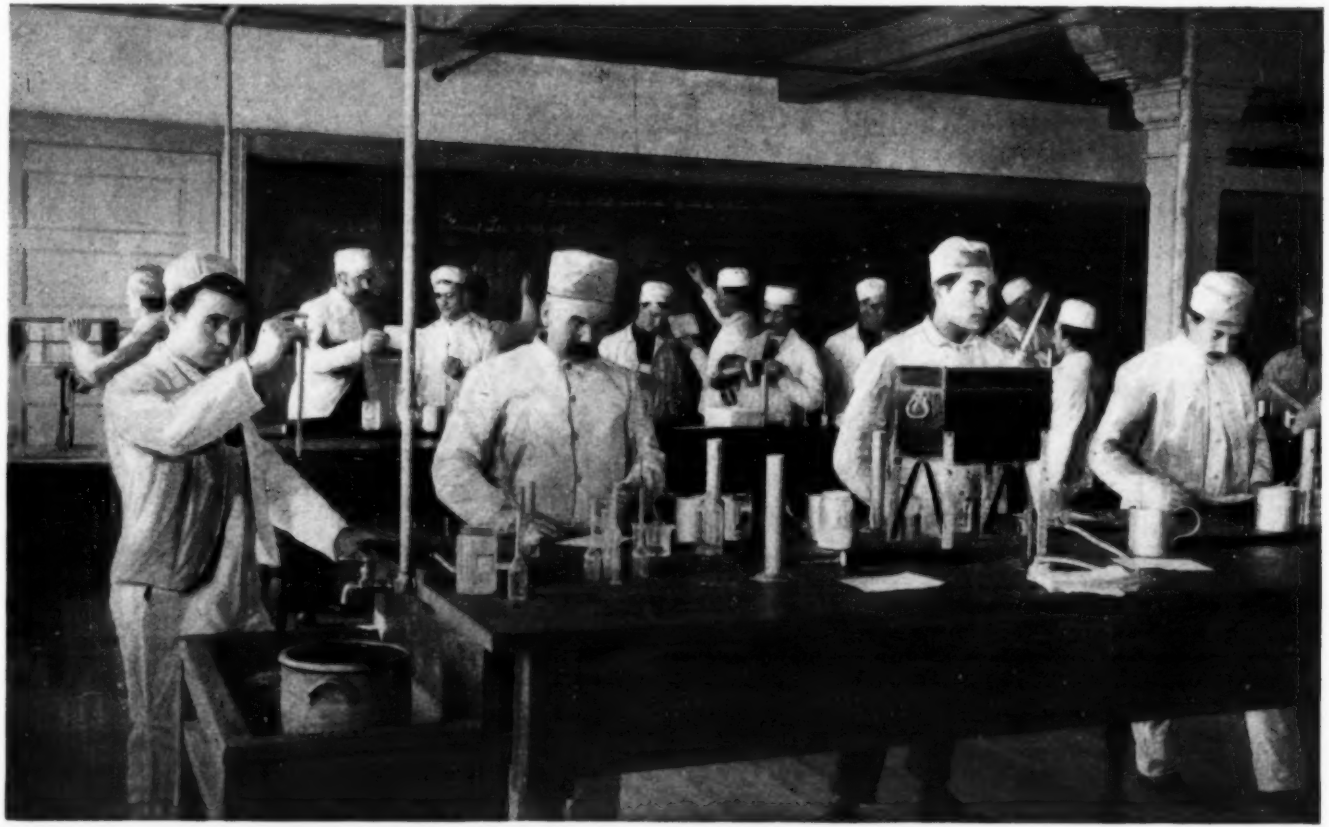


FIG. 1.—VIEW OF MILK-TESTING LABORATORY, WISCONSIN DAIRY SCHOOL.

handling and care of milk and cream, and of the cream and butter in and out of the churn, are almost unknown to thousands of butter-makers, and more especially to the private, non-professional ones among these, who are in the great majority. The engineers have their mechanical colleges and their schools of technology, the doctors have their medical schools, and the druggists their pharmacy colleges, but the dairy farmers have had practically no place where they could receive instruction in the theory and practice of butter and cheese making. I am aware that there have been agricultural colleges in the United States since 1855, but as far as practical instruction in dairying is concerned a good many of them might as well not have existed at all, if I do not radically misjudge the situation. Lectures in dairying, in which the principles of butter-making were to be taught, were certainly included in the curricula of some of the colleges, under the charge of the Professor of Agriculture, but this gentleman most likely also had charge of the feeding and breeding of farm animals, cultivation of crops, soil physics, farm management, and other studies. It is not strange that the attention given to dairy matters and to the manufacture of dairy products could only be very scant under these conditions. There were so many important problems to be taken up and discussed in relation to general agricultural topics that time would not permit entering into details, even if the professor had the inclination to do so.

This state of affairs led to the establishment of separate schools for instruction in dairying, especially in the manufacture of butter and cheese. Such schools have existed in Europe for a number of years; here they were not introduced until four years ago, when the Wisconsin Dairy School was founded as a separate department of the Agricultural College of the University of Wisconsin. So spontaneous was the growth of this school, and so rapid the adoption of the system in many other States of the Union, that it surprised the most ardent supporters of the movement.

The Wisconsin Dairy School dates from January, 1890, when a short dairy course was arranged for students taking the winter course in the College of Agriculture; two out of the twenty-seven agricultural students took this dairy course. The following year, when the course was greatly widened and the dairy school proper organized, seventy-two students entered, crowding the quarters of the school to the very utmost. The Wisconsin Legislature having in 1891 appropriated twenty-five thousand dollars for a separate dairy-school building, the work was at once pushed forward; where a crop of corn was taken off the ground in September, 1891, a neat, substantial edifice was erected, the first story of which was ready for occupancy in January, 1892, and in March the first class

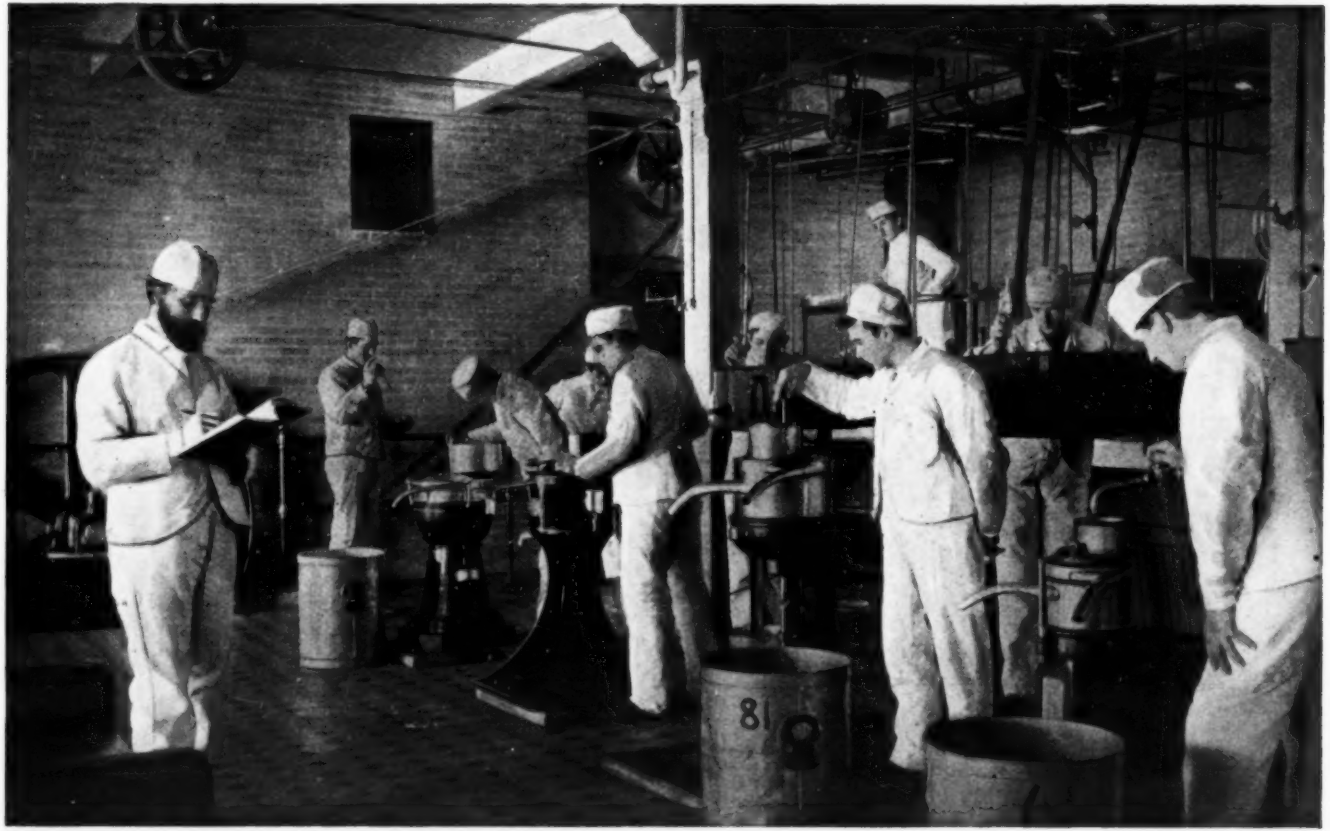


FIG. 2.—VIEW OF SEPARATOR ROOM.

of students from the new dairy school was graduated, thus securing for the university two crops from the same land within a year. The building was finished during the summer of 1892, and is a model in appearance and equipment. Its cost up to date with equipment amounts to nearly forty thousand dollars. The name of the building, Hiram Smith Hall, was given it in honor of the veteran Wisconsin dairyman, Hon. Hiram Smith (1890), for twelve years a regent of the University and chairman of the Farm Committee of the Board of Regents, to whose enthusiasm and untiring efforts the school largely owes its existence. The building is calculated to accommodate one hundred students, and this number was reached the first year. Last year one hundred candidates applied for admission before December 1st, although the school did not begin until January 4th, and later applicants had to be turned away. Students have come from Canada and almost every State in the Union where dairying is a leading industry: Minnesota, Illinois, and Michigan have furnished their quota; so have Maine and California; New Hampshire and Nevada; New York, Indiana, Iowa, Missouri, and Kansas.

We can not here enter into a detailed description of the courses of instruction offered in the school, but a short outline of the same will be given. Only branches bearing directly on the science and practice of dairying and on the manufacture of dairy products are taught. The policy of the governing board is to make the instruction thoroughly practical; at the same time the theoretical side is considered no less important. The professors and instructors connected with the school are specialists in their various branches; the instructors in the cheese room and the creamery are expert cheese and butter makers.

The instruction is given, first, by lectures; second, by work at the separators, the churns, and the cheese vats, as well as in the laboratory. Lectures are given in the following branches: The breeds and breeding of dairy cows, the feeding of dairy cows, diseases of dairy cows, the chemistry of milk and its products, bacteriology of the dairy products, physical problems connected with the dairy, and the care and management of the boiler and engine. These subjects are presented to the class by different professors of the university.

The practical work is taught in the butter and cheese room, as well as in the laboratory. The picture of the separating room shows the arrangement of the separators. Of these all the latest and most improved patterns are kept, as well as of the butter extractor. It may be in order to state, for the benefit of the many readers who never were inside of a creamery or a farm dairy, that a cream separator or a *centrifuge*, as it is sometimes called, is a machine for separating the cream from the skim milk by means of

centrifugal force. A strong steel bowl is made to rotate by hand-power or steam, at a speed of five to eight thousand revolutions per minute; by this means the heavier portion of the milk, the skim milk, is separated from the lighter portion, the cream, and both are collected in separate vessels.

The work in the creamery room includes the handling and care of the cream previous to churning, the churning, and the working and packing of the butter. In the cheese room, where there are eight milk vats, each of a capacity of three hundred pounds, thirty-two students may work at the same time; the various steps in cheese-making, from the proper handling of the milk to the curing of the cheese, are here learned.

A most important part of the instruction is the milk testing, which is taught in the laboratory. Farmers' boys, who previously to their entering the school knew nothing whatever about the different components of milk, here learn to determine the percentage of fat in milk, skim milk, buttermilk, whey, and cream, with almost as great accuracy as any experienced chemist, and certainly as satisfactorily for all practical purposes. This has been made possible by the introduction of the Babcock test for the determination of fat in milk, a method invented nearly four years ago by Dr. S. M. Babcock, chief chemist to the Wisconsin Experiment Station. The method has won for its originator a world-wide reputation and the gratitude of progressive dairy farmers in this and other countries. The test, which was given to the public without any restriction of patent, is extremely simple, and may be made on a farm or in a creamery or cheese factory as well as in a chemical laboratory, everywhere with equal correctness and facility. In the dairy school the percentage of fat in milk is determined by Babcock's test, and by a combination of the test and the lactometer (a simple apparatus to determine the specific gravity of milk or its weight in relation to water), adulteration of the milk, and the extent of the same may be detected.

The course of the dairy school lasts three months—viz., January to March, inclusive. The expenses of the school while in operation are very heavy; the milk bill alone thus amounts to eighty dollars a day during this time. In addition to this course, dairy certificates are issued to such graduates of the school as have shown proficiency in the operation of a creamery or a cheese factory for one or more seasons; candidates for such certificates must send in reports of their work once a month to the dean of the college; their factories are further inspected by an instructor of the school, to ascertain whether or not the candidate may be granted a certificate, and thereby given the recommendation of the State Dairy School as a successful butter or cheese maker.

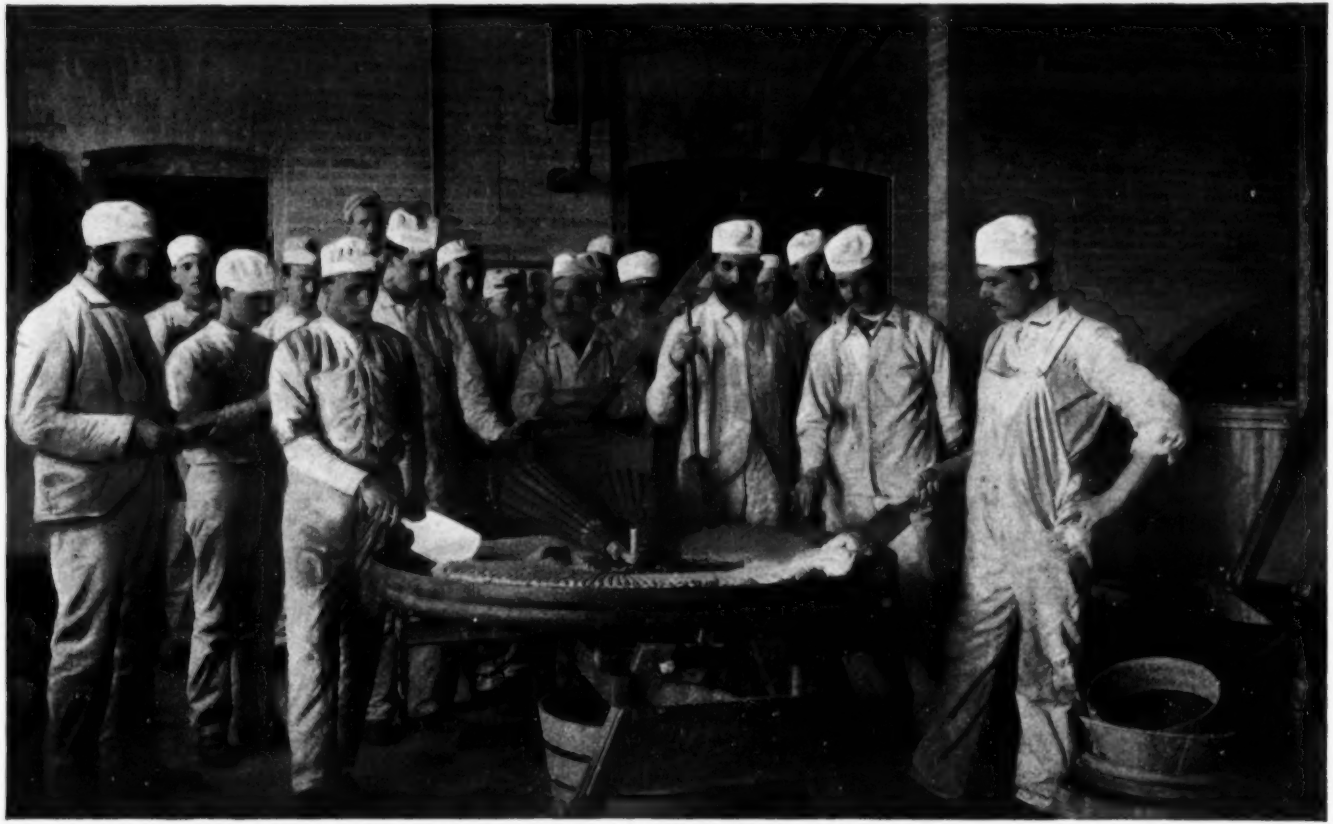


FIG. 3.—STUDENTS AT THE BUTTER WORKER.

Dairy schools on a similar plan as the one just described have been in operation during the past year or two at the Agricultural Colleges of Minnesota, Pennsylvania, Vermont, Iowa, and New York (Cornell). Other States will doubtless establish similar schools in the near future, as the demand for instruction in these branches is steadily increasing, and students are taxing to the utmost the capacity of the schools existing.

Only a small proportion of the milk produced in the United States is obtained on farms situated in the direct neighborhood of cities where the milk can be sold as such; in all other places it must be manufactured into butter or cheese. Where the population of a district is not sufficient to support a butter or cheese factory, the manufacture of dairy products, and primarily butter, must take place on the farm itself. Modern invention has greatly facilitated the work of butter-making on the farm; by the introduction of hand separators all apparatus for setting the milk, either in ice tanks or in a separate milk room, in metal or wooden vessels, may be done away with; the cream is obtained at once by the separator, and thus only one fifth of the quantity of material has to be taken care of, as the skim milk may be fed directly to calves or pigs. These hand separators are made in various sizes to suit the requirements of different herds. They are not very expensive, so that any farmer of moderate means can buy them. The manufacturers claim for them, and without exaggeration, that they will pay their cost each year over and above any other system, with a herd of ten or more cows, on account of the larger yield of butter obtained with them from the same quantity of milk. In other systems of creaming a much larger portion of the fat in the milk is left in the skim milk, which is thus lost for butter-making.

The modern churns, which are mostly barrel-shaped or of rectangular form, make churning mere play. The method of butter-making now generally adopted is about as follows: The cream is churned at about 56° to 62° Fahr., the temperature differing somewhat with the season and the ripeness of the cream. The butter will come after twenty to forty minutes' turning, sometimes more, sometimes less, according to acidity, temperature, and other conditions present. The buttermilk is then drawn off through a hole near the bottom of the churn, and the butter washed in the churn, placed on the butter worker to free it as completely as possible from buttermilk, and then salted (one ounce of salt to one pound of butter); again worked and packed in tubs, and is now ready for shipment. Our pictures show the making of creamery and of dairy butter.

In this country cheese is made almost entirely in factories; as many will know, the process employed in the making of our ordi-

FIG. 4.—BUTTER-MAKING APPARATUS FOR SMALL DAIRIES.

nary Cheddar cheese is as follows: The milk is heated to 86° Fahr., in the cheese vat; one to four ounces of rennet extract is then added, according to the kind of cheese desired. The rennet coagulates the milk in less than half an hour; when the curd is firm, it is cut into small cubes by means of cheese knives, and heated slowly to 98° Fahr.; after about two hours the whey is ready to be drained off, the curd put on racks, and various operations gone through, of no special interest to the general reader; it is then salted (two to three pounds of salt to one thousand pounds of milk containing four per cent fat), put in hoops and pressed for twenty-four hours, and finally placed in the curing room. The more rennet is added to the milk, the quicker the cheese will cure; the more salt, the slower it will cure. Cheddar cheese ought to cure at least two months before it is put on the market, but is often sold only a couple of weeks old.

I have barely touched upon the main features in the manufacture of dairy products in the preceding. While it does not take very long to learn the important steps in their manufacture, it requires good common sense and thorough knowledge of the composition and properties of dairy products and the many conditions affecting the various processes, in order to become a successful butter or cheese maker. No cast-iron rules can be laid down in most cases, and no man can therefore make the kind of butter and cheese that you and I like, unless he understands his work thoroughly and uses good judgment in the discharge of his duties.

The dairy industry of the United States can not help receiving a grand impetus through the agency of the dairy schools; the quantity of dairy products will be increased through a better selection of animals, through more liberal, systematic feeding and better care being taken of them, and the quality of the products will be improved by a thorough understanding of the theory and practice of their manufacture. The magnitude of our dairy industry makes this educational work a most important one. The value of the annual product of butter and cheese made on farms or in factories in the United States in 1880, according to the tenth census, amounted to nearly one hundred and forty million dollars. More than eight hundred million pounds of butter and two hundred and forty million pounds of cheese were made during 1880. When it is remembered that the average annual yield of butter per cow in the United States does not exceed one hundred and twenty-five pounds, while single herds give three and even four hundred pounds a year per cow—when, furthermore, the mass of butter sells at an average of less than fifteen cents a pound, while private parties obtain fifty cents or more a pound for their butter —then we understand what a grand opportunity is offered to

educators for missionary work in this line. This work our dairy schools, agricultural experiment stations, dairymen's associations, and similar organizations are doing, and American dairying is rapidly progressing toward a higher standard through their agencies.

THE ICE AGE AND ITS WORK.

By ALFRED R. WALLACE, F. R. S.

EROSION OF LAKE BASINS.—(*Continued.*)

IV.

THERE is really only one alternative theory to that of ice erosion for the origin of the class of lakes we have been discussing, viz., that they were formed before the Glacial epoch, by earth movements of the same nature as those which are concerned in mountain formation, that is, by lateral pressure causing folds or flexures of the surface; and where such flexures occurred across a valley a lake would be the result. This is Prof. Bonney's theory given in his paper in the Geographical Journal, and it is also that of Desor, Forel, Favre, and other eminent geologists. It is explained fully in the work of M. Falsan (already quoted), who also adopts it; and it may be considered, therefore, that if this theory can be shown to be untenable that of glacial erosion will hold the field, since there is no other that can seriously compete with it. Prof. Bonney considers this theory completely satisfactory, and he complains that the advocates of glacial erosion have never discussed it, intimating that they "deemed silence on this topic more prudent than speech."

As this theory is put forward with so much confidence, and by geologists of such high reputation, I feel bound to devote some space to its consideration, and shall, I think, be able to show that it breaks down on close examination.

In the first place, it does not attempt to explain that wonderful absence of valley lakes from all the mountain regions of the world, except those which have been highly glaciated. It is, no doubt, true that during the time the lakes were filled with ice instead of water, they would be preserved from filling up by the influx of sediment; and this may be fairly claimed as a reason why lakes of this class should be somewhat more numerous in glaciated regions, but it does not in any way explain their total absence elsewhere. We are asked to believe that in the period immediately preceding the Glacial epoch—say, in the Newer Pliocene period—earth movements of a nature to produce deep lakes occurred in every mountain range without exception that was

about to be subject to severe glaciation, and not only so, but occurred on both sides of each range, as in the Alps, or all round a mountain range, as in our lake district, or in every part of a complex mountain region, as in Scotland from the Frith of Clyde to the extreme north coast—all in this very limited period of geological time. We are further asked to believe that during the whole period from the commencement of the Ice age to our day such earth movements have never produced a single group of valley lakes in any one of the countless mountain ranges and hilly regions throughout the whole of the very much more extensive non-glaciated regions of the globe! This appears to me to be simply incredible. The only way to get over the difficulty is to suppose that earth movements of this nature occurred only at that one period, just before the Ice age came on, and that the lakes produced by them in all other regions have since been filled up. But is there any evidence of this? And is it probable that *all* lakes so produced in non-glaciated regions, however large and deep they might be, and however little sediment was carried down by their inflowing streams, should yet all have disappeared? The theory of the pre-glacial origin of these lakes thus rests upon a series of highly improbable suppositions entirely unsupported by any appeal to facts. There is, however, another difficulty which is perhaps even greater than those just considered. Whatever may be the causes of the compression, elevation, folding, and other earth movements which have led to the formation of mountain masses, there can be no doubt that they have operated with extreme slowness; and all the evidence we have of surface movements now going on show that they are so slow as to be detected only by careful and long-continued observations. On the other hand, the action of rivers in cutting down rocky barriers is comparatively rapid, especially when, as in all mountainous countries, they carry in their waters large quantities of sediment, and during floods bring down also abundance of sand, gravel, and large stones. A remarkable illustration of this erosive power is afforded by the river Simeto, in Sicily, which has cut a channel through solid lava which was formed by an eruption in the year 1603. In 1828, Sir Charles Lyell states, it had cut a ravine through this compact blue rock from fifty to several hundred feet wide, and in some parts from forty to fifty feet deep.* The enormous cañon of the Colorado, from three thousand to five thousand feet deep and four hundred miles long, which has been entirely cut through a series of Mesozoic and Palæozoic rocks during the latter portion of the Tertiary period, is another example of the wonderful cutting power of running water.

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* Principles of Geology, eleventh ed., vol. i, p. 353.

It is, in fact, only on account of this powerful agency that we do not find valley lakes abounding in every mountainous country, since it is quite certain that earth movements of various kinds must have been continually taking place. But if rivers have always been able to keep their channels clear, during such movements, among the mountains of the tropics and of all warm countries, some reason must be found for their inability to do so in the Alps and in Scotland, in Cumberland, Wales, and southern New Zealand; and as no reason is alleged, or any proof offered, that sufficiently rapid and extensive earth movements actually did occur in the subalpine valleys of these countries, we must decline to accept such a hypothetical and unsatisfactory explanation.

Nothing is more easy, and nothing seems at first sight more plausible, than to allege these "earth movements" to account for any one lake whose origin may be under discussion. But it ceases to be either easy or plausible when we consider the great number of the lakes to be accounted for, their remarkable positions and groupings, and their great depths. We must postulate these movements, all about the same time, in every part of the Highlands of Scotland, everywhere in the Lake district, and on both sides of the Alps. Then, again, the movements must have been of greater extent just where we can prove the glaciation to have been most severe. It produced lakes from one hundred feet to two hundred and seventy feet deep in Cumberland and Westmoreland; in Scotland, where the ice was much thicker, the lakes are from over three hundred to over one thousand feet deep; while in the Alps of Switzerland and North Italy, with its vast glaciers and ice-sheets, many are over one thousand feet, and one reaches the enormous depth of over twenty-five hundred feet. It may be said that the depth is in proportion to the height of the mountains; but in equally high mountains that have not been glaciated there are no lakes, so this can not be the true explanation. One more remarkable coincidence must, however, be pointed out. The two largest Swiss lakes—those of Geneva and Constance—are situated just where the two greatest West European rivers, the Rhone and the Rhine, get beyond the mountain ranges; while on the south, one of the largest and by far the deepest of the lakes—Lake Maggiore—collected into its basin the glacier streams from a hundred miles of the high Alps, extending from Monte Rosa on the west to the peaks above San Bernardino on the east. Throughout this great curve of snowy peaks the streams converge, with an average length of only thirty miles, to unite in a valley only six hundred and forty-six feet above the sea level. No such remarkable concentration of valleys is to be found anywhere else in the Alps, and no other lake reaches to nearly so great a depth. On the theory of glacial erosion we have here cause and effect; on that

of earth movements we have another mere coincidence added to the long series already noticed. The depth of over twenty-five hundred feet undoubtedly seems enormous, but that depth exists just at the point where the two great valleys which have collected the converging streams above referred to unite together. Geologists will probably not think thirty thousand years an extravagant estimate for the duration of the Glacial period, in which case an erosion of only an inch in a year would be sufficient. Lago di Garda, the largest Italian lake, had a still larger catchment area in glacial times but not nearly so much concentrated; hence, perhaps, its comparatively moderate depth of about one thousand feet. We see, then, that on the theory of erosion, the size, depth, and position of the chief lakes are all intelligible, while on that of earth movements they have no meaning whatever, since the deep-seated agencies producing subsidence, upheaval, or curvature of the surface would be as likely to act in the small as in the large valleys, and to produce deep lakes in other places than those where, at a later epoch, the thickest glaciers accumulated.

THE CONTOURS AND OUTLINES OF THE LAKES INDICATE EROSION RATHER THAN SUBMERGENCE.—While collecting facts for the present articles, it occurred to me that the rival theories of lake formation—erosion and submergence—were so different in their modes of action that they ought to produce some marked difference in the result. There must be some criteria by which to distinguish the two modes of origin. Under any system of earth movements a valley bottom will simply become submerged, and be hardly more altered than if it had been converted into a lake by building an artificial dam in a convenient situation. We should find, therefore, merely a submerged valley with all its usual peculiarities. If, however, the lake basin has been formed by glacial erosion, then some of the special valley features will have been destroyed, and we shall have a distinct set of characters which will be tolerably constant in all lakes so formed. Now I find that there are three such criteria by which we ought to be able to distinguish the two classes of lakes, and the application of these tests serves to show that most of the valley lakes of glaciated countries were not formed by submergence.

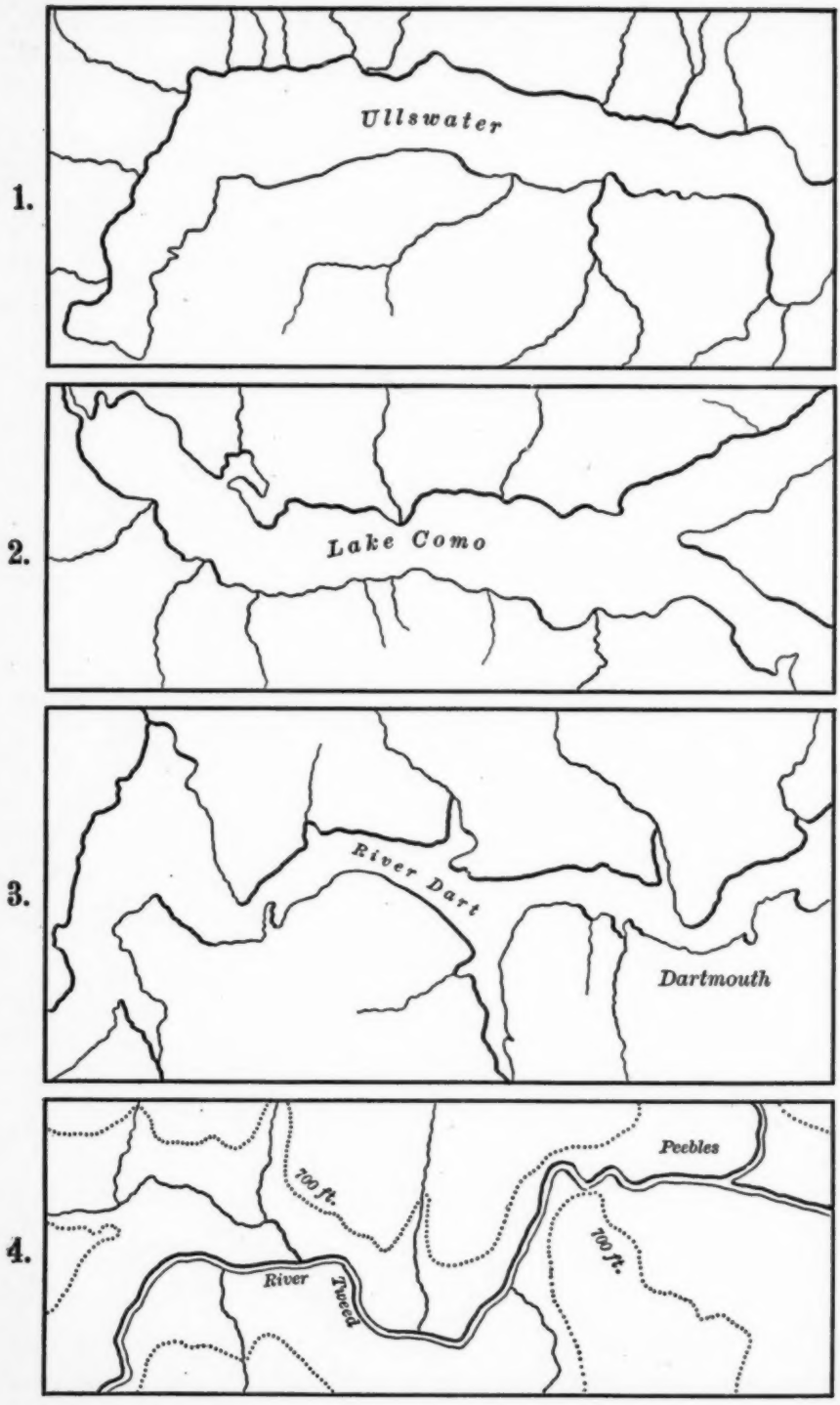
The first point is that valleys in mountainous countries often have the river channel forming a ravine for a few miles, afterward opening out into a flat valley, and then again closing, while at an elevation of a hundred or a few hundred feet, at the level of the top of the ravine, the valley walls slope back on each side, perhaps to be again flanked by precipices. Now, if such a valley were converted into a deep lake by any form of subsidence, these ravines would remain under water and form submerged river

channels. But neither in the lakes which have been surveyed by the Swiss Government, nor in the Atlas des Lacs Françaises of M. Delebecque, nor in those of the German Alps by Dr. Alois Geistbeck, nor in the lakes of our own country, can I find any indications of such submerged river channels or ravines, or any other of the varied rock features that so often occur in valleys. Almost all these lakes present rather steeply sloping sides with broad, rounded, or nearly level bottoms of saucer shape, such as are certainly not characteristic of subaërial valley bottoms, but which are exactly what we might expect as the ultimate result of thousands of years of incessant ice grinding. The point is, not that the lake bottoms may not in a few cases represent the contours of a valley, but that they never present peculiarities of contour which are not unfrequent in mountain valleys, and never show submerged ravines or those jutting rocky promontories which are so common a feature in hilly districts.

The next point is, that Alpine lake bottoms, whether large or small, frequently consist of two or more distinct basins, a feature which could not occur in lakes due to submergence unless there were two or more points of flexure for each depression, a thing highly improbable even in the larger lakes and almost impossible in the smaller. Flexures of almost any degree of curvature are no doubt found in the rocks forming mountain chains; but these flexures have been produced deep down under enormous pressure of overlying strata, whereas the surface beds which are supposed to have been moved to cause lakes are free to take any upward or downward curves, and, as the source of motion is certainly deep-seated, those curves will usually be of very gradual curvature. Yet in the small lake of Annecy there are two separate basins; in Lake Bourget also two; in the small lake of Aiguebellette, in Savoy, there are three distinct basins of very different depths; and in the Lac de St. Point, about four miles long, there are also three separate flat basins. In Switzerland the same phenomenon is often found. In the Lake of Neufchâtel there are three basins separated by ridges from twenty to thirty feet above the deeper parts. The small Lac de Joux, at the head of a high valley in the Jura, has also three shallow basins. Lake Zurich consists of three well-marked basins. The exceedingly irregular Lake of Lucerne, formed by the confluence of many valleys meeting at various angles hemmed in by precipitous mountains, has eight distinct basins, mostly separated by shallows at the narrow openings between opposing mountain ridges. This is exactly what would result from glacier action, the grinding power of which must always be at a maximum in the wider parts of valleys, where the weight of the ice could exert its full force and the motion be least impeded. On the subsidence or curvature

theory, however, there is no reason why the greatest depth should occur in one part rather than in another, while separate basins in the variously diverging arms of one lake seem most improbable. The lakes of Thun and Brienz form two basins of what was evidently once a single lake. The upper or Brienz basin is enormously deep, over two thousand feet, and the reason is obvious. The combined glaciers of the Lauterbrunnen and Grindelwald Valleys entered the main valley in a direction almost opposite to that of the Aare, piling up the ice against the great barrier of the Rieder Grat, so that it at length flowed downward with greatly increased grinding power; while lower down, toward Thun, the valley opens widely and would thus allow the ice to spread out with greatly diminished thickness. In our own country Loch Lomond and Ullswater have been found to consist of several distinct basins, and in none of our lakes have any indications of submerged river channels yet been found.

The third point of difference between lakes of erosion and those of submersion is the most important and the most distinctive, and furnishes, I think, what may be termed a diagnostic character of lakes of erosion. In most river valleys through a hilly or mountainous country outside of the glaciated districts, the tributary streams entering more or less at right angles to the main valley are seen to occupy small valleys of their own, which usually open out for a short distance at the same level before joining the main valley. Of course, there are also torrents which rush down steep mountain slopes directly to the main river, but even these have usually cut ravines more or less deeply into the rock. Now, if in such a valley we could mark out a contour line two hundred, three hundred, or five hundred feet above the level of the main stream, we should see that line continually turning up each side valley or ravine till it reached the given level at which to cross the tributary stream, and then turning back to the main valley. The contour line would thus form a series of notches or loops of greater or less depth at every tributary stream with its entering valley or deeply cut ravine, and if the main valley were filled with water this line would mark out the margin of the lake. As an illustration of this feature we may take the southwest coast of England, which has never been glaciated, but which has undergone a slight recent subsidence, as indicated by the submerged forests which occur at several places. The result of this submergence is that the lower parts of its larger river valleys have been converted into inland tidal lakes, such as Poole Harbor, Dartmouth Harbor, Kingsbridge River, Plymouth and Devonport Harbors, and Carrick Road above Falmouth. The Dart River is an excellent example of such a submerged valley, and its outline at high-water mark is shown at (3) on the accom-



Lake Forms due to Erosion (1, 2); to Submersion (3, 4).

panying cut, where the characteristic outline of such a valley is well indicated, the water running up every tributary stream, as described above. The lower section (4) shows the same feature by means of a map of the river Tweed, near Peebles, with the seven hundred feet contour line marked on it by a dotted line.* If the valley were submerged to this depth the dotted line would mark the outline of a lake, with arms running up every tributary stream just as in the case of the river Dart. Although situated in a glaciated district the valley here is post-glacial, all the old river channels being deeply buried in drift.

If we now turn to the valley lakes in glaciated districts we shall find that they have a very different contour, as shown by the two upper outline maps on the same page: (1) showing the upper part of Ullswater on a scale of one mile to an inch, as in the Dart and Tweed maps; and (2) showing the upper part of Lake Como, taken from the Alpine Club map, on a scale of four miles to an inch. In both of these it will be seen that the water never forms inlets up the inflowing streams, but all of these without exception form an even junction with the lake margin, just as they would do if flowing into a river. Exactly the same feature is present in the lower portions of these two lakes, and it is equally a characteristic of every lake in the Lake district, and of all the Swiss and Italian lakes. On looking at the maps of any of these lakes one can not but see that the lake *surface*, not the lake *bottom*, represents approximately the level of the pre-glacial valley, and that the lateral streams and torrents enter the lake in the way they do because they could only erode their channels down to the level of the old valley before the ice overwhelmed it. Of course, this rule does not apply to large tributary valleys carrying separate glaciers, since these would be eroded by the ice almost as deeply as the main valley.

The three features of the valley lakes of glaciated regions now pointed out—the absence of submerged ravines or river channels either of the main river or of tributary streams; the basin forms of the lake bottoms and the frequent occurrence of two or more separate basins even in small lakes; and the simple form of surface contour of all this class of lakes, so strongly contrasting with that of valleys known to have been recently submerged, as well as with the contour lines of valleys in non-glaciated districts and in those which are known to be post-glacial—seem to afford, as nearly as the case admits, a demonstration that the lakes presenting these features have been formed by erosion and not by submergence.

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* Copied from a portion of the map at page 144 of Geikie's Great Ice Age, taken from the Ordnance Survey Map.

In connection with this subject may be noticed the many cases in which Alpine valleys present indications of having been greatly deepened by glacial erosion, although, owing either to the slope of the ground or the uniformity of the ice action, no lake has been produced. In some valleys, as in that of Lauterbrunnen, the trough between the vertical rock walls was probably partly formed before the Ice age, but was greatly deepened by glacial erosion, the result being that the tributary streams have not since had time to evacuate ravines of equal depth with the main valley, and therefore form a series of cascades over the lateral precipices, of which the Staubbach is the finest example. In many other cases, however, the side streams have cut wonderfully narrow gorges by which they enter the main vally. This work was probably begun by a subglacial stream, and the action of the atmosphere being shut out by the superincumbent ice and all variation of temperature avoided, the torrent cut for itself a very narrow groove, sometimes with overhanging sides, as it found layers of somewhat softer rock to eat away; and the upper surface of the rock being ground smooth by the ice, the atmosphere has had little effect since, and the gorge, while deepened below, has remained as restricted above as when first eroded. Such are the gorges of the Trient, Leuk, Pfäffers, and many others well known to Alpine tourists. I am not aware whether such extremely narrow winding gorges, often only two or three feet between the rock walls, are to be found in countries which have never been glaciated. I do not myself remember reading of any, though, of course, tremendously deep ravines are common, but these are of quite a different character. Should it be found that these extremely narrow rock-walled gorges are peculiar to glaciated districts they will afford us a means of estimating the amount of glacial erosion in valleys where no lake basins have been formed.

THE LAKE OF GENEVA AS A TEST OF THE RIVAL THEORIES.—When I recently began to study this question anew, I was inclined to think that the largest and deepest of the Alpine lakes, such as Geneva, Constance, Lago Maggiore, and Lago di Garda, might perhaps have originated from a combination of earth movements with ice erosion. But on further consideration it appears that all the characteristic features of erosion are present in these as fully as in the smaller lakes. They are situated in the largest river valleys or in positions of greatest concentration of the glacier streams; their contours and outlines are those of eroded basins; while all the difficulties in the way of an origin by earth movements are as prominent in their case as in that of any other of the lakes. I will therefore discuss, first, some of the chief objections to the erosion theory as applied to the above-named lake,

and then consider the only alternative theory that has obtained the acceptance of modern writers.

One of the first objections made was, that the lake did not lie in the direction of the greatest action of the glacier, which was straight across to the Jura where the highest erratic blocks are found. This was urged by Sir Charles Lyell, immediately after Ramsay's paper was read, and as it has quite recently been put forth by Prof. Bonney, it would appear to be thought to be a real difficulty. Yet a little consideration will show that it has not the slightest weight. No lake was eroded in the line of motion of the central and highest part of the old glacier, because that line was over an elevated and hilly plateau, which is even now from five hundred to a thousand feet above the lake, and was then even higher, since the ice-sheet certainly effected some erosion. The greatest amount of erosion was of course in the broad and nearly level valley of the pre-glacial Rhone, which followed the great curve of the existing lake, and had produced so open a valley *because the rocks in that direction were easily denuded.* Objectors invariably forget or overlook the indisputable fact that the existence of a broad, open, flat-bottomed valley in any part of a river's course proves that the rocks were there either softer or more friable, or more soluble, or by some combination of characters more easily denuded. A number of favorable conditions were combined to render ice erosion easy in such a valley. The rock was, as we have shown, more easy to erode; owing to the low level the ice was thicker and had greater weight there than elsewhere; owing to the flatness and openness of the valley the ice moved more freely there; owing to the long previous course of the glacier its under surface would be heavily loaded with rock and grit, which during its whole course would, by mere gravitation, have been slowly working its way downward to the lowest level; and, lastly, all the subglacial torrents would accumulate in this lowest valley, and, as erosion went on, would, under great hydrostatic pressure, wash away all the ground-out material, and so facilitate erosion. To ask why the lake was formed in the valley, where everything favored erosion, rather than on the plateau, where everything was against it, is to make mere verbal objections which have no relation to the conditions that actually existed.

Another objection almost equally beside the real question is to ask why the deepest part of the lake is near the south or convex side, whereas a stream of water always exerts most erosive force against the concave side.* The answer is, that ice is not water, and that it moves so slowly as to act, in many respects, in quite a

* Falsan, La Période Glaciaire, p. 153. Fabre, Origine des Lacs Alpins, p. 4.

different manner. Its greatest action is where it is deepest—in the middle of the ice stream—while water acts least where it is deepest, and more forcibly at the side than in the middle. The lake is, no doubt, deepest in the line of the old river, where the valley was lowest; and that may well have been nearer the southern than the northern side of the lake.

Another frequently urged objection is, that as the glacier has not widened the narrow valley from Martigny to Bex it could not have eroded a lake nearly a thousand feet deep. This seems to me a complete *non sequitur*. As a glacier erodes mainly by its vertical pressure and by the completeness of its grinding armature of rock, it is clear that its grinding power laterally must have been very much less than vertically, both on account of the smaller pressure because it would mold itself less closely to the ever-varying rocky protuberances, and mainly, perhaps, because at the almost vertical sides of the valley it would have a very small stony armature, the blocks continually working their way downward to the bottom. Thus, much of the ice in contact with the sides of narrow ravines might be free of stones, and would therefore exert hardly any grinding power. It is also quite certain that the ice in this narrow valley rose to an enormous height, and that the chief motion and also the chief erosion would be on the lateral slopes, while the lower strata, wedged in the gorge, would be almost stationary.

The most recent researches, according to M. Falsan, show that the thickness of the ice has been usually underestimated. A terminal moraine on the Jura at Chasseron is four thousand feet above the sea, or twenty-seven hundred and seventy feet above Geneva. In order that the upper surface of the ice should have had sufficient incline to flow onward as it did, it was probably five thousand or six thousand feet thick below Martigny and four thousand or five thousand feet over the middle of the lake. It is certain, at all events, that whatever thickness was necessary to cause onward motion, that thickness could not fail to be produced, since it is only by the onward motion to some outlet or lowland where the ice can be melted away as fast as it is renewed that indefinite enlargement of a glacier is avoided. The essential condition for the formation of a glacier at all is that more ice should be produced annually than is melted away. So long as the quantity produced is on the average more than that melted, the glaciers will increase; and as the more extended surface of ice, up to a certain point, by forming a refrigerator helps its own extension, a very small permanent annual surplus may lead to an enormous extension of the ice. Hence, if at any stage in its development the end of a glacier remains stationary, either owing to some obstacle in its path or to its having reached a level plain,

where it is unable to move onward, the annual surplus of ice produced will go to increase the thickness of the glacier and its upper slope till motion *is* produced. The ice then flows onward till it reaches a district warm enough to bring about an equilibrium between growth and dissolution. If, therefore, at any stage in the growth of a glacier a thickness of six, seven, or even eight thousand feet is needed to bring about this result, that thickness will inevitably be produced. We know that the glacier of the Rhone *did* move onward to the Jura and beyond it; that the northward branch flowed on beyond Soleure till it joined the glacier of the Rhine; and that its southern branch carried Alpine erratics to the country between Bourg and Lyons, two hundred and fifty miles from its source. We know, too, that throughout this distance it moved at the bottom as well as at the top, by the rounded and polished rocks and beds of stiff bowlder clay which are found in almost every part of its course.

In view, therefore, of the admitted facts, all the objections alleged by the best authorities are entirely wanting in real force or validity; while the enormous size and weight of the glacier and its long duration, as indicated by the great distance to which it extended beyond the site of the lake, render the excavation by it of such a basin as easy to conceive as the grinding out of a small Alpine tarn by ice not one fourth as thick, and in a situation where the grinding material in its lower strata would probably be comparatively scanty.

We have now to consider the theory of Desor, adopted by M. Favre, and set forth in the recent work of M. Falsan as being "more precise and more acceptable" than that of Ramsay. We are first made acquainted with a fact which I have not yet alluded to, and which most writers on the subject either fail to notice or attempt to explain by theories, as compared with which that of Ramsay is simple, probable, and easy of comprehension. This fact is, that around Geneva at the outlet of the lake, as well as at the outlets of the other great lakes, there is spread out an *old alluvium* which is always found *underneath the bowlder clay and other glacial deposits.* This alluvium is, moreover, admitted to be formed in every case of materials largely derived from the great Alpine range. Now here is a fact which of itself amounts to a demonstration that the lakes *did not exist* before the Ice age; because, in that case all the Alpine *débris* would be intercepted by the lake (as it is now intercepted), and the alluvium below the glacial deposits would be, in the case of Geneva, that formed by the wash from the adjacent slopes of the Jura; while in every case it would be local not Alpine alluvium.

Prof. James Geikie informs me that he considers the so-called "old alluvium" to be probably only the fluvio-glacial gravels and

sands swept out from underneath the advancing glacier, and therefore to be no older, geologically, than the moraine matter which overlies it. The Swiss geologists, however, do not appear to hold this view, since they have recourse to a very remarkable hypothesis in order to overcome what they evidently believe to be a real difficulty in the way of the pre-glacial origin of the lake. The suggested explanation is as follows: At the beginning of the Ice age the glacier of the Rhone crept on down its valley past Martigny and St. Maurice till it reached the lake; it is then supposed not to have marched on with an ice wall, say five hundred or more feet high, but to have at once spread out like so much soft pitch, and to have filled the lake to its present water level or thereabouts. Then, over this great plain of ice, the subglacial torrent of the Rhone is supposed to have flowed, carrying with it and depositing at the end of the lake that ancient alluvium which, somehow, has got to be accounted for! *

Having thus filled the lake with ice instead of water, the main body of the glacier is supposed to start afresh and to travel over the ice, and thus obviate the imaginary difficulty of a glacier moving up hill, though every student of glaciers now admits that they did so, and though it is universally admitted that this very glacier of the Rhone moved over higher, steeper, and more irregular hills on its way to the Jura and to Soleure.

Now this extraordinary theory involves two difficulties which are passed by in silence, but which seem to entirely contravene all that we know of the nature of glaciers, and to be entirely unsupported by facts. The first is, the glacier ceasing to move onward as a glacier, but spreading out to fill up a lake basin, as if the lake were simply frozen to the bottom. Is this conceivable or possible? I think not. When glaciers come down to a fiord or to the sea they do not spread out laterally, but move on till the water is deep enough to buoy them up and break off icebergs, and no reason is given why anything different should have happened in the case of the great Swiss and Italian lakes, supposing they existed before the Ice age came on. That the glacier should afterward slide over this level plain of ice is equally inconceivable, in view of the property of regelation of ice under pressure. Owing to this property the glacier and the lake ice would become one mass, and would move on together under the law of decreasing velocity with depth. This, however, is of little importance if, as I conceive, the supposition of the formation of an ice-sheet at the water level for fifty miles in advance of the glacier is an impossible one. The only other theory is, that the lake was filled up by alluvium before the Ice age, and that the glacier re-excavated it. I have,

* A. Falsan, La Période Glaciaire, pp. 135, 137.

however, already given reasons why the glacier would not have done so, and the very existence of this ancient alluvium in the course of the ancient glacier is a proof that it did not do so. This theory seems now to have no supporters.

SUMMARY OF THE EVIDENCE.—As the subject here discussed is very complex, and the argument essentially a cumulative one, it will be well briefly to summarize its main points.

In the first place, it has been shown that the valley lakes of highly glaciated districts form a distinct class, which are highly characteristic if not altogether peculiar, since in none of the mountain ranges of the tropics or of non-glaciated regions over the whole world are any similar lakes to be found.

The special conditions favorable to the erosion of lake basins and the mode of action of the ice-tool are then discussed, and it is shown that these conditions have been either overlooked or ignored by the opponents of the theory of ice erosion.

The objections of modern writers are then considered, and they are shown to be founded either on mistaken ideas as to the mode of erosion by glaciers, or on not taking into account results of glacier action which they themselves either admit or have not attempted to disprove.

The alternative theory—that earth movements of various kinds led to the production of lake basins in all mountain ranges, and that those in glaciated regions were preserved by being filled with ice—is shown to be beset with numerous difficulties, physical, geological, and geographical, which its supporters have not attempted to overcome. It is also pointed out that this theory in no way explains the occurrence of the largest and deepest lakes in the largest river valleys, or in those valleys where there was the greatest concentration of glaciers, a peculiarity of their distribution which points directly and unmistakably to ice erosion.

A crucial test of the two theories is then suggested, and it is shown that both the subaqueous contours of the lake basins and the superficial outlines of the lakes are exactly such as would be produced by ice erosion, while they could not possibly have been caused by submergence due to any form of earth movements. It is submitted that we have here a positive criterion, now adduced for the first time, which is absolutely fatal to any theory of submersion.

Lastly, the special case of the Lake of Geneva is discussed, and it is shown that the explanation put forth by the anti-glacialists is wholly unsupported by facts and is opposed to the known laws of glacier motion. The geologists who support it themselves furnish evidence against their own theory in the ancient alluvium at Geneva on which the glacial deposits rest, and which is admitted to be mainly derived from the distant Alps. But as all alluvial

matter is necessarily intercepted by large and deep lakes, the presence of this Alpine alluvium immediately beneath the glacial *débris* at the foot of the lake indicates that the lake did not exist in pre-glacial times, but that the river Rhone flowed from the Alps to Geneva, carrying with it the old alluvium, consisting of mud, sand, and gravel, which it had brought down from the mountains. Still more conclusive, however, is the fact that the three special features which have been shown to indicate erosion rather than submergence are present in this lake as fully as in all other Alpine valley lakes and unmistakably point to the glacial origin of all of them.

On the whole, I venture to claim that the facts and considerations set forth in this paper show such a number of distinct lines of evidence, all converging to establish the theory of the ice erosion of the valley lakes of highly glaciated regions—a theory first advocated by the late Sir Andrew Ramsay—that that theory must be held to be established, at all events provisionally, as the only one by which the whole body of the facts can be explained and harmonized.—*Fortnightly Review.*

[*Concluded.*]

SKETCH OF GERARD TROOST.

GERARD TROOST, one of the founders and first President of the Academy of Natural Sciences of Philadelphia, was born at Bois-le-Duc, Holland, March 5, 1776, and died in Nashville, Tenn., August 14, 1850. He attended the Universities of Leyden and Amsterdam, devoting special attention to chemistry, geology, and natural history; received the degree of Doctor of Medicine from the University of Leyden, and that of Master in Pharmacy, in 1801, from the University of Amsterdam. He practiced his art for a short time at Amsterdam and the Hague; served in the army as a private soldier, and at another time as an officer of the first class in the medical department; and during these periods of service was wounded in the thigh and in the head. In 1807 he went to Paris, under the patronage of Louis Napoleon, King of Holland, to pursue his studies, and then he became the pupil and associate of the Abbé René Just Haüy, author of the famous system of crystallography. He traveled in France, Italy, Germany, and Switzerland, and collected a valuable cabinet of minerals, which was purchased by the King of Holland. In 1809, this king appointed Troost to accompany, in a scientific capacity, a naval expedition to Java. He was captured by an English privateer; confined for some time at Dunkirk; returned to Paris; and

then made his way to la Rochelle. He took passage from a northern port, beyond French jurisdiction, in an American vessel, for New York, whence he hoped to reach the East Indies under the protection of our flag. This vessel was captured by a French privateer and carried to Dunkirk, where Troost was kept a prisoner till the French became aware of his true name and character, when he was released. He went at once to Paris. In March, 1810, he was elected a correspondent of the Museum of Natural History of Paris. A few days afterward he was allowed to embark again on an American vessel for Philadelphia. The turn of political events in Europe, among which was the abdication of Louis Napoleon as King of Holland and the surrender of Java to England, caused him to abandon his contemplated visit to the East Indies and to remain in the United States.

In 1812 Dr. Troost participated in the foundation of the Academy of Natural Sciences in Philadelphia and became its first president. Of the origin of this society, Dr. W. S. W. Ruschenberger, from whose account we derive much of the material of this sketch, says there were some young persons in Philadelphia disposed to study the laws of creation. Occupied with their business during the day, they were accustomed to converse concerning natural phenomena when they met in the evening, without appointment, at the ordinary places of resort. They very often met at the apothecary's shop of John Speakman, of whom Thomas Say was subsequently the business partner, at the corner of Market and Second Streets. At one of these meetings Mr. Speakman suggested that if the young men could be induced to meet at stated times, where they would be secure from interruption, to communicate to one another what they might learn about the phenomena of Nature, they would derive more pleasure and profit than from desultory and irregular conversation. The suggestion was seconded by Jacob Gilliams, and a meeting was appointed for the next Saturday evening at Mr. Speakman's house, for the young men and such of their friends as might be interested in the matter: Six persons were present at the meeting, January 25, 1812; Dr. Gerard Troost, Dr. Camillus Macmahon Mann, Jacob Gilliams, John Shinn, Jr., Nicholas Parmentier, and John Speakman, host. The meeting was described in the minutes as "a meeting of gentlemen, friends of science, and of rational disposal of leisure moments"; and it was agreed that the exclusive object of the society should be the cultivation of natural science. For the furtherance of this purpose all matters of politics and religion were rigorously excluded, even allusions to them being forbidden. It was perhaps from this determination, Dr. Ruschenberger suggests, that "the erroneous notion

sprang, which, according to tradition, prevailed with some, that the object of the institution was to favor religious infidelity." The constitution of the society was agreed upon on the 17th of March, and the name Academy of Natural Sciences was adopted on the 21st of that month, which date was established as that of the beginning of the institution. On that day, too, the members agreed "to contribute to the formation of a museum of natural history, a library of works of science, a chemical experimental laboratory, an experimental philosophical apparatus, and every other desirable appendage or convenience for the illustration and advancement of natural knowledge, and for the common benefit of all the individuals who may be admitted members of our institution." Among the first donors of minerals were Dr. Troost, Mr. Isaac Lea, Dr. Hays, and Mr. S. Hazard. When the small room, 121 North Second Street, hired about the 1st of April, was occupied, the members came forward with their gifts to serve as the nucleus of the museum and library. Among them was Dr. Troost, with some artificial crystals, prepared by himself. On the occasion of the election of officers, May 7, 1812, Dr. Troost was chosen president. He held this office five years, or till 1817, when he resigned and was succeeded by William Maclure. On the 15th of August, 1812, the collection of minerals previously purchased from Dr. Seybert by Mr. Speakman came formally into the possession of the society, which formed a kind of joint-stock company to pay for it and hold it. Soon after this, Dr. Troost delivered a course of lectures on mineralogy before the academy.

During his residence in Philadelphia Dr. Troost was engaged in manufactures of various kinds. In 1815 or 1816 he began the manufacture of alum on the Magothy River, Cape Sable, Maryland, establishing the first alum works in the United States. In 1821 he was appointed Professor of Mineralogy in the Philadelphia Museum, where he delivered lectures on the subject. He was also appointed about the same time first Professor of Chemistry in the College of Pharmacy, Philadelphia, a position which he resigned, after having delivered one course of lectures, in the succeeding year. During this period he also made geological excursions into New Jersey, New York, and elsewhere.

In 1825 Dr. Troost, with Maclure, Say, and Lesueur, joined Robert Owen in the formation of the Communistic Society at New Harmony, Ind. After remaining there two years, he removed to Nashville, Tenn., in 1827. In 1828 he was elected, at the instance of President Lindley, Professor of Chemistry, Geology, and Mineralogy in the University of Nashville. In a historical sketch, published in the catalogue of 1850, is a table of the longest terms of official service of instructors. It is headed by President Lind-

ley, twenty-six years; and next in length of service comes Prof. Troost, from February 9, 1828, to August 14, 1850, twenty-two years and a half.

In 1831 he was appointed State Geologist of Tennessee, an office which he held till it was abolished in 1839. The record of his work in this department is preserved in his reports. The first and second reports were not published. The third report, made in 1835, contains the results of the geologist's investigations respecting the extent of the coal formations in the State. "I have ascertained," it says, "that the places in which coal may be expected belong exclusively and entirely to that group of mountains which are known by the name of Cumberland Mountains, and are composed of Walden's Ridge, Crab Orchard Mountain, Brimstone Mountain, and some other subordinate ridges of the same system." The breadth of the formation was greatest near the northern limit of the State, and in one part the coal was represented as deposited in horizontal strata of great extent. The report also deals largely with marl, iron, and soils, and concludes with the words: "In a scientific point of view my labors have been very advantageous. I have been very fortunate in obtaining organic remains which were unknown, and which eventually will show how far our strata correspond with those on the old continent. I have discovered parts of the American or *gigantic mastodon* hitherto unknown."

The fourth report, of 1837, relates to the Ocoee district, comprising a part of the mountain region near the North Carolina boundary, which Prof. Troost was directed by the State Legislature to explore. It begins with an exposition of the principles of geology and their application to the general structure of the district under view, for the information of the people; an admirable specimen of exact scientific writing adapted to popular comprehension, explicit, lucid in style, and showing familiarity with the subject. The character of the region is depicted in a few words: "Commencing our reconnaissance at the most northern extremity of the district, I found the rocks at Tallassee, on the Tennessee River, entirely composed of grauwacke, alternating here and there with limestone; this is the case everywhere along the Tennessee River, where I was able to approach and examine them, to the Smoky Mountain, which forms the southeastern limit of the district, and separates Tennessee from North Carolina. It is almost impossible to penetrate any distance in this wild and mountainous country; and the apparent confusion of the rocks, which seem at some places heaped up without order, and changing at small distances, makes the geological survey hazardous and extremely difficult." The author calls attention to the roofing slates of East Tennessee, and dwells upon the value of slates

generally; regards the prospects of finding paying gold as not promising; but speaks of having observed at several places between the Ocoee and Hiawassee Rivers hydroxide of iron similar to the ore used in Middle Tennessee in the blast furnaces. "It is superfluous," he adds, "to expatiate here on the importance of iron works in a country which is not susceptible of cultivation, where there is an inexhaustible supply of wood." He suggests in this report a hypothesis that Lookout and Raccoon Mountains and the Cumberland Mountains were once connected, and that the Tennessee River cut a passage between them; and he gives reasons for believing that the old bed of the river may be found where it enters the Sequatchy Valley. A note is added to the report, giving a list of the fossils the geologist had collected during his survey. He believed that his collection, particularly of fossils characterizing the mountain limestone of Tennessee, was unrivaled. It was his desire to have them figured and described, and published as an appendix to the work of Dr. Goldfuss on organic remains, of which he had announced a translation—but "the prospect of publishing it without pecuniary loss is not flattering." The list contains nearly a hundred entries, some of which include many species.

In his fifth report, made for 1839, Dr. Troost said that he had traversed the State in many directions, and analyzed a large number of minerals, mineral soils, and other materials, which, though not belonging properly to the department of the geologist, were deemed necessary to be known as constituting sources of our national wealth. The report gives a general view of the geology of the whole State, in which all the terms are clearly and fully explained. It deals with iron ores, timber, and water powers, and points out the suitableness of the region of the Smoky Mountains for grass and stock and the cultivation of potatoes and cabbage—adding that "no country can be better calculated for the raising of sheep." Prof. Troost insisted that iron must become one of the principal sources of wealth of Middle and East Tennessee, which were even more favored in the distribution of ores than Missouri with its Iron Mountain, and "nowhere could a foundry for a national arsenal be more judiciously situated than in our State, the center of the Union, and therefore not liable to be attacked by an enemy, and yet by means of its large rivers, and soon perhaps of railroads, cannon or other arms may be transported in a short time to any point in the Union." Descriptions of iron ore and iron works are given with some detail. The list of organic remains is accompanied with descriptions and includes a hundred and sixteen entries.

The ninth report, for 1847, deals chiefly with zinc ores, their reduction, and the manufacture of zinc and brass.

Of the report made in 1849 the American Journal of Science and Arts said: "The geographical survey of Tennessee, under Dr. Troost, is still in progress, and is bringing to light many additions to science, besides developing the various resources of the State. Prof. Troost is well known for his learning, his skill, and his enthusiasm in his investigation, and it is greatly to the honor of Tennessee that such a *savant* is appreciated and his talents are called into action. In a recent communication from Dr. Troost he mentions that the number of the new genera and species of *Crinoideæ* which occur in the State of Tennessee is really surprising. His geological report, now before the Legislature of the State of Tennessee, contains a monograph of *Crinoideæ* in that State, in which sixteen new genera and eighty-eight new species are described, illustrated by two hundred and twenty figures; this number not only surpasses that of those discovered in the other States of the Union, but perhaps is equal to those that have been found over the whole of Europe."

Besides his geological reports of Tennessee, Dr. Troost contributed to the Philadelphia Society for Promoting Agriculture, A Geological Survey of the Environs of Philadelphia, the territory included in which embraced a semicircular area having a radius of fifteen miles from the center at the Rotunda in High Street, and bounded on the east by the Delaware River. A preliminary note described the paper as "an attempt to delineate the geological positions of our environs, and to give some general ideas of the nature and chemical constituents of our soil." Of the pamphlet of forty pages, containing a colored map, ten pages were devoted to the geological survey, fifteen pages to descriptions of soils, and ten pages to their composition. Prof. Troost also published in the Transactions of the Geological Society of Pennsylvania an account of the organic remains and various fossils of Tennessee and adjacent States; in the Bulletin of the Geological Society of France, a memoir on the organic remains and fossils of Tennessee; and in Silliman's American Journal of Science and the Arts, articles on Amber at Cape Sable, Maryland; Minerals of Missouri; Coral Regions of Tennessee; Analysis of a Meteorite from Tennessee; Meteoric Iron from Tennessee and Alabama; A Shower of Red Matter in Tennessee; Three Varieties of Meteoric Iron; Meteoric Iron of Murfreesboro', Tenn.; and Krausite and Cacorene in Tennessee. He translated Humboldt's Aspects of Nature into Dutch. He gathered a collection of about fifteen thousand mineralogical and more than five thousand geological specimens, constituting what was at the time considered the finest cabinet belonging to a single person in the United States. Besides the Philadelphia Academy, he was a member of the

American Philosophical Society, the Geological Society of Pennsylvania, the Geological Society of France, and of other scientific bodies in America and Europe.

A minute adopted by the Board of Trustees of the University of Nashville, on the occasion of the death of Prof. Troost, relates that, "born and liberally educated in Holland, he early manifested a zealous devotion to natural history and chemistry, more especially to the then infant sciences of geology and mineralogy. With a view to the more successful pursuit of his favorite studies he visited Paris, and was for several years the pupil of the celebrated Haüy. He removed to the United States about forty years ago, and in due time became an American citizen. His entire life was consecrated to geology and the kindred sciences, with what ability and success his published writings and his well-earned reputation at home and abroad may eloquently testify. As a professor in this university during the last twenty-two years and a State geologist of Tennessee for the most part of that period, he won the confidence and respect of the community by invaluable service in both capacities, as well as by the unaffected modesty, kindness, and uniform courtesy of his deportment toward all men. In the various relations and stations of life, public and private, he was without reproach and above suspicion. Beloved, trusted, honored, venerated by all those most intimately connected or associated with him, he could not make an enemy—he had none."

GEOGRAPHY as a whole was compared by Dr. H. R. Mill, in the introduction to his course of educational lectures of the Royal Geographical Society, to a pyramid of six courses of masonry, built of blocks obtained from different quarries. The first and fundamental course, built of material derived from pure mathematics, was mathematical geography, absolutely secure and firmly established, underlying all the rest. Upon it, and resting on it, rose physical geography, the material for which was brought from physics, geology, meteorology, etc., all the determining conditions being fully known. This served as a foundation for biological geography, in which the imperfect comprehension of life introduced unstable and incomplete elements; but far fuller of uncertainty was the next tier of anthropo-geography, in which the additional unknown quantity of human nature exercised a preponderating influence, and the positive scientific facts from the quarries of anthropology, ethnology, and economics were few and by no means well co-ordinated. Arising from this came the layer of political geography, the scientific basis of which was mixed up and overlaid with arbitrary, transitory, and impracticable conditions arising from the workings of the human mind and the limitations of nationality. Upon this was reared the final story of the pyramid, commercial geography, a mass of rubble, the relation of which to its scientific foundation was not yet fully made out.

CORRESPONDENCE.

MISTAKES OF SCIENTIFIC MEN, ARTISTS, AND POETS.

Editor Popular Science Monthly:

In late numbers of this journal public attention has been called to errors in the statement of facts or of scientific points, by men who should have known better. But errors of the kind you name are not confined to a few, but are found everywhere—even among poets and artists, as well as among men of science.

Some years ago a French artist was employed to paint a panel on the west wall of the room belonging to a lodge. He made a beautiful evening landscape, having the sun in the horizon. A little above, and toward one side, was the *full moon*. The shadows of the trees in the foreground all pointed to the *moon* as their source, although the whole circle of the sun was still in view. I called his attention to this want of conformity to the facts—but the picture was too good to be spoiled by corrections; so it remained as it was made.

There is a beautiful hymn by Seagrave, found in many church collections, having a part of a stanza as follows:

> "Rivers to the ocean run,
> Nor stay in all their course;
> Fire, ascending, seeks the sun,
> *Both speed them to their source.*"

[All the Italics in this letter are my own.] The science contained in these lines is that of the ancient heathen philosophy, viz., that things heavy naturally *tend downward*, things light naturally *tend upward*.

The attribute of intelligence thus given to the fire has but a sorry exemplification, seeing that all fires which burn in the night fail to get a right start in their search for the sun. Of course, it is meant that the fire goes upward of its own accord—is not driven by anything else.

A distinguished professor of physics in an Ohio college many years ago was accustomed to say in his lectures that "hot air rises, and the cold air rushes in to fill the vacuum." I once called his attention to the slip. He acknowledged the error—and then continued to speak as before, much after the manner of the devil when he was sick and wished to be a monk.

The same absurd statement appears in The Popular Science Monthly for last November, page 104, in the article on the origin of The Mississippi Valley Rainfall. We find as follows: "They [the winds] flow as on an inclined plane, over the colder and more dense air toward the north, and thus restore the equilibrium of the atmosphere that has been disturbed. This disturbance is caused by a continual flow of the cold and heavy surface air from the extreme north toward the equator, because along the tropical belt *a partial vacuum is created* by the air becoming heated and lighter, and in consequence *floating upward, and the cold air rushes in to supply that vacuum.*" There it is.

Again, in the February number of this year, page 466, in the article on the Physical Conditions of the Deep Sea, occurs this passage: "The particles of water thus heated *immediately commence to rise through the superjacent layers of colder water, and the colder particles would fall to take their places.*"

On the principles of the ancient philosophy these extracts are all right, but according to the principles of modern physics they are all wrong. Your own rebuke to such carelessness was well deserved—let us hope that it may produce needed reformation.

R. W. McFarland.

Columbus, Ohio, *April* 1, 1894.

DO ANIMALS REASON?

Editor Popular Science Monthly:

The February number of The Popular Science Monthly has just arrived, and I should like to add to the article on the Psychology of a Dog two illustrations.

When my father was in the navy during the late war, his ship, the United States bark Pursuit, lay at St. Joseph's Bay, Florida. There was on board a dog (half pointer) called "Secesh" because he had been captured from the "rebs." One day the men went on shore, taking "Secesh" with them, but when the time came to return the dog was nowhere to be seen, and the men were obliged to go back without him. Half an hour later Secesh appeared upon the beach and, finding the boat had gone, he started to swim for the vessel; but before he reached it the tide caught him and was carrying him rapidly out to sea; he thereupon swam back to the shore, trotted rapidly up the beach for a considerable distance, and again struck out for the ship, this time reaching it in safety.

Again: my grandmother was possessed of a small dog of no particular breed. One evening she, with my grandfather, was talking of going to visit her mother, some twenty miles distant, on the following day. Dick, the dog, lay on the hearth at their feet. My grandmother remarked that they had better shut Dick up before they started or he would follow them. In the morning Dick was nowhere to be found, and they were obliged to

start without fastening him. They had proceeded a number of miles on their journey when they came to a place where two roads diverged. There at the fork of the roads sat Dick, serenely waiting to find which road to take. You may be sure he was not sent back.

Is it not certain that these dogs must have reasoned, and if they reasoned, is it not logical to conclude that dogs have a mind; then, if they have a mind, is this mind not immortal? Any child may ask these questions, but what child or philosopher will give them a satisfactory answer?

HELEN BLACKMER POOLE.

SPRINGFIELD, MASS., *January* 19, 1894.

EDITOR'S TABLE.

THE POSSIBILITIES OF EDUCATION.

THE article from the pen of Prof. C. Hanford Henderson, which appeared in our last number under the title of Cause and Effect in Education, is one deserving of more than passing attention. The point he sought to make was that education as an art can hardly be said as yet to have entered on its scientific stage, seeing that it is still haunted by so many unverified *a priori* conceptions, and that the true limits and conditions of successful working are still far from being generally understood. The general subject is one which has been very often discussed in these columns, but it is also one on which there always seems to be another word to say.

Education, from one point of view, is a debt which the adult generation owes to that which is to succeed it. This civilization to which we have attained, these general ideas, these intellectual resources, these moral principles, these habits and customs of proved utility—how are they to be passed on to those who are to succeed us? By education—that is to say, by mental contact and moral sympathy between those who know and those who as yet do not know. That is the problem in its most general aspect. Here we may make two reasonable assumptions: the first, that all we have learned the rising generation may also learn; the second, that possibly, nay probably, it is not worth the while of the rising generation to learn *all* that we have learned. We can not teach our children more than we know, but we can teach them less than we know, and so leave room for their own independent acquisitions. It behooves us, therefore, to sift our knowledge and whatever else we have to impart, and consider very carefully what is worth passing on and what is not. Much good, we believe, would come from a serious and earnest facing of this question, What should I teach or have taught to my child in its own best interest? Things which we ourselves have learned, perhaps with considerable effort or at considerable cost in other ways, we are apt to attach a fictitious value to, simply because they have cost us dear; but the spirit of virtuosity should not enter into education; let the child become a *virtuoso* after his own fashion later if circumstances lead him to do so, but meantime let our chief effort be to give him a free and healthy mind in a free and healthy body.

One thing is certain: every child, every human being, wants the full use of his senses and other natural faculties. Eyes were made to see with, ears to hear with, vocal organs to speak and sing with, and hands to feel with. Any system of education, therefore, that is inspired by true benevolence toward the child will start by taking stock of his natural endowments, so as to correct, as far as possible, any defects that may attach to them and provide for their fullest development. Children are often far from perceiving the benevolent intent in the systems of education

to which they are subjected; and it is little wonder, in general, that it should be so. But, if an effort were being vigorously made to carry every natural faculty they possessed to its perfection—to make the eyes quick and true, the voice sweet and full, the hearing sensitive and discriminating, the bodily movements vigorous and graceful, and so on—the beneficence of the process would impress itself even on the juvenile mind, and thus half the battle would be gained, for we want the children's confidence before we can do them much good. Nothing, we believe, would do so much toward the development of the all-important quality of self-respect as a careful physical training. It would, on the one hand, promote individuality, inasmuch as the child would be made to feel what he or she was capable of individually, and, on the other, it would promote a true comradeship, as it would awaken a consciousness of that common physical nature, with its varied powers, of which all partake.

Here, therefore, is a part of education about which there can be no mistake—a preparation for perfect living in the physical sense—that perfect living which economizes both mental and moral force, and places the individual in a position of advantage for the accomplishment of all the ends of life. Under a system which made due provision for this kind of training, questions of diet, of clothing, of exercise, of ventilation, of bodily habits, and so forth, would, of course, be carefully considered, and whatever was best in all these respects would be suitably held up for guidance and instruction. It is true that there is much that is defective from a hygienic point of view in the home life of nearly all classes, and on that very account it is important that true hygienic principles should be inculcated, in a manner as free as possible from pedantry, in the schools; for if the children can be taught simply and clearly the conditions on which their health and comfort depend, they will themselves exert a wholesome influence in the household.

What Paul said to the Athenians might be said to-day to ourselves: We are in all things too superstitious, and particularly in the matter of education. Instead of seeking as we do now to see how much we can cram into youthful minds, or in other words how much of the elastic force of the brain we can destroy—for that is what it comes to in at least a multitude of cases—we should consider all so-called knowledge contraband of the childish mind until its assimilable character has been fully demonstrated. When we are satisfied that it will act as food and not as the mere stuffing of the taxidermist to bulge out the intellectual nature into a conventional shape, let us impart it, and not before; but do not let us give too much even of food, remembering that the animal which goes in search of its own food gets the highest and best development, the most ingeniously adapted structure, the widest range of faculty. The most fatal fault we can commit is that of unduly taming and domesticating the mind, so to speak, so that it expects to be fed by others, instead of going abroad to see what the universe will do for it.

The more we expect from education, the less we are apt to get from it in the way of useful results. We form an idea of a highly rationalized man of refined intellectual and artistic tastes, with perhaps a large element of moral idealism, and generally "up to date"; and that we set up, as Nebuchadnezzar did his brazen image, for all the world to bow down to. The object of education, we think, is to produce something like that. Well, education isn't going to do it. Men of that kind have always been exceptional, nor is it education that has given them the qualities we so much admire. If education had done it for them, why then, doubtless, it could do it for others; but what do we see? From the same

form in school, perhaps from the same household, one will rise to honor and another sink to dishonor; one will become conspicuous in society, another will never emerge from obscurity. But what education *will* do, if we work on natural lines, if we are not too fussy over it, and are careful not to give it in too large doses, will be to liberate and more or less wisely direct a vast amount of intellectual power which at present we confine and almost paralyze. Good and sensible people are often heard groaning over the vulgar and frivolous enjoyments which alone seem to afford any pleasure to the multitude; and there is some reason for the plaint, though the multitude may not be so much to blame as is supposed. It is a question of intellectual energy. The man or woman who has much of it to spare will not be a frequenter of the mere spectacular drama, nor a devourer of coarsely sensational novels. What excuse is sometimes given by our busy men for their very inferior taste in literary, dramatic, and other matters? Oh, that they are so fagged out by their day's work that they want the stimulus of something sensational. The excuse is worked for all that it is worth; but in some cases there is something in it. As regards a much larger number, however, both of men and of women, the trouble probably is that their intellectual faculties were not only not strengthened or invigorated by their early education, but were more or less dwarfed and numbed. If a youth were to go through an alleged course of athletic training and were to come away with dwindled muscles and a more languid condition of body than he had when he began, we could at once, on the evidence of our senses, pronounce the whole thing a fraud. The mind, unfortunately, does not admit of the same simple measurements as the muscles, and we can not therefore so easily detect the fraud when, after from five to ten years of schooling, a young person steps out into the world with less of intellectual apprehensiveness and less of available mental vigor than he or she had as a little child. Yet, that this has been, and still is, a not infrequent result, who will deny?

There are great possibilities of good in education if we will but recognize our proper *rôle* in the matter, and not try to usurp the place of the one consummate teacher—Nature. There are vast possibilities of evil in it if, planting ourselves on dogmas, traditions, and classicisms, or attaching too absolute an authority to our own generalizations, we seek to dominate the minds whose gradual evolution we should patiently watch and cautiously and tenderly assist. Most of us probably have more or less teaching to do: let us remember that, so far as this is the case, our art is not that of the taxidermist or constructor of lay figures, but that we have living tissue to deal with; and let us respect the mysteries of life and growth.

IS "SOCIETY" VULGAR?

Some weeks ago a prominent clergyman of this city was reported to have expressed the opinion that the "society" of to-day is vulgar. Reporters called upon him to ascertain if he really had said anything so dreadful, and he was obliged to confess that he had, and that he really thought he had spoken the truth. It is evident that whether he did speak the truth or not depends on the sense we attach to the word vulgar. If to be vulgar means to live plainly and without ostentation, then society is not vulgar, but very much the opposite. If to be vulgar means to take unconventional views of things, and to estimate men and women more according to their intellectual and moral qualities than by the wealth they possess and the figure they are able to cut in the world of fashion, then to say that society is vulgar is a cruel slander. If to be vulgar is to be unversed in social forms, but sincere in friendship,

then society deserves no such reproach. Finally, if to be vulgar means to possess and cultivate individuality, to study the principles of taste, and to consider these as more entitled to respect than the dictates of fashion, to regard advantages of wealth and position as held in trust for mankind at large, and to make the enjoyment of pleasure secondary to the performance of duty, the accusation of vulgarity is very much beside the mark.

The word "vulgar," as we all know, means "appertaining to, or characteristic of, the multitude." We have not turned up the word in the dictionary, for we feel sure this definition will suffice. An infallible rule, therefore, for being vulgar according to the measure of your ability, is to keep your eye on others, so that whatsoever they do you may do also, irrespective of your own judgment as to the merits of the particular act or course of action. If you begin to study the right or wrong of the thing, to consider whether what suits, or seems to suit, others is also suitable to you—if, in a word, you bring private judgment and a moral or æsthetic conscience to bear on the matter—you at once run the risk of not being vulgar, and that is a risk which a good many persons do not care to run. "As well out of the world as out of the fashion" is the whole law and gospel of vulgarity, seeing that it is the maxim which compels people to abnegate and set at nought their private judgment, and act blindly in troops at the bidding of some unseen and possibly very despicable master of ceremonies.

We begin to see now, perhaps, what the eminent clergyman meant when he said that "society" was vulgar. He did not mean any of the things first hinted at. He was thinking of the essential meaning of the word. He saw, with a clearness of vision which it would be well if all ministers of the gospel possessed, that luxury does not shut out vulgarity, that so-called polite manners are not incompatible with it, that even educational acquirements may only, like varnish, bring out its grain more distinctly. He saw that "society," when all is said and done, lives mainly to eat and drink and nourish the bodily senses; that far from believing in and cultivating individuality, it represses it to the utmost; that, instead of discussing, like citizens of a free republic, the codes by which it is governed, it only asks to know that they have been imposed by some recognized authority; that, in a word, it is whatever is most commonplace, glorified by the power of gold. So he ventured to say it was vulgar, and, if it is not, then what is it? It is, broadly speaking, a region of tinsel, of monotonous routine, of rival vanities so alike in their expression that one is hardly to be distinguished from another, and of slavish imitation. The way of escape from this City of Destruction lies through the cultivation of individuality and thoughtfulness for others. As the essence of vulgarity is to be a selfish, unreflecting slave of fashion, so the farthest remove from it is to be a freely thinking, judging, and acting individual, seeking ever higher modes of life, and desiring to communicate as much of good as possible to others. The aim of education ought to be to rescue from vulgarity and win over to a broad humanity—to plant the law of reason in the mind and the law of love in the heart.

The several psychological works of Prof. James Sully are so widely read and frequently cited in America that their author needs no introduction to the readers of the Monthly. Accordingly, we feel that we are making a very welcome announcement in stating that Prof. Sully has consented to contribute to this magazine a series of articles embodying some of the studies of mental development in childhood that he has been making during the past few years. The first of these articles, under the

special title, The Age of Imagination, will appear in our July number. It deals with what the author calls "the *play* of imagination, the magic transmuting of things through the sheer liveliness and wanton activity of a child's fancy." The mind of the child is still a little-explored country, and an examination of it under Prof. Sully's competent guidance will not only have the charm of novelty but will also furnish much helpful insight to all who have the care of children.

LITERARY NOTICES

EDWARD LIVINGSTON YOUMANS, INTERPRETER OF SCIENCE FOR THE PEOPLE: A SKETCH OF HIS LIFE, WITH SELECTIONS FROM HIS PUBLISHED WRITINGS AND EXTRACTS FROM HIS CORRESPONDENCE WITH SPENCER, HUXLEY, TYNDALL, AND OTHERS. By JOHN FISKE. New York: D. Appleton & Co., 1894. Pp. 600. Price, $2.

FEW men of this generation in America have better deserved an enduring monument to their memory than the late Prof. Edward L. Youmans. Such a monument, we may trust, is supplied by the ably written biography by Prof. Fiske. The author was intimately acquainted with him for many years, and has produced a most interesting and pleasing sketch of his character and career, one marked, as might have been expected, by ardent and enthusiastic sympathy with his subject, yet equally characterized by moderation and good taste. Let us first glean a few of the biographical details furnished by Mr. Fiske.

Edward Livingston Youmans was born in the town of Coeymans, Albany County, N. Y., on the 3d of June, 1821. His father, Vincent Youmans, is described as "a man of independent character, strong convictions, and perfect moral courage," and his mother, Catherine Scofield, as "notable for balance of judgment, prudence, and tact." Both father and mother belonged to the old Puritan stock of New England, and in Edward Youmans the best and richest qualities of that stock came to the surface—"sagacity and penetration, broad common sense, earnest purpose, veiled but not hidden by a blithe humor, devotion to ends of practical value, and the habit of making in the best sense the most out of life."

A few months after Edward Youmans was born, his father, who pursued the occupation of wagon-maker, removed from Coeymans to Greenfield, in Saratoga County. Here and in the neighboring town of Milton, to which he removed ten years later, five other sons and one daughter were born, and Edward, as the eldest child, took an active and very willing part in looking after the younger ones. Until his sixteenth year he helped his father at work in summer and attended the district school in winter. The most wholesome feature of such schools was an absence of overregulation. It was one that Edward learned early to appreciate, and he always cherished a distrust of excessive organization and a dislike to machine methods.

At the age of thirteen the youth became possessed of a copy of Comstock's Natural Philosophy, and shortly set to work to repeat some of the experiments therein described. He next obtained a copy of Comstock's Manual of Chemistry, which he studied as best he could by himself, for his school-teacher had no knowledge whatever of the subject. From it he gathered the opinion, as Prof. Fiske tells us, that, "when men have once learned how to conduct agriculture upon sound scientific principles, farming will become one of the most wholesome and attractive forms of human industry."

Such was the youth of Edward Youmans, such the stock from which he sprang, such his original habitat and environment. Our narrative up to this point presents no remarkable features, and yet this home-bred youth was destined to do a great work—to be, if we may use the expression, the foster-father of a great system of philosophy on the North American continent, the virtual leader of the intellectual forces that rallied under the banner of evolution. As a man he had these two great qualifications for practical success: he knew a good thing when he saw it, and what his hand found to do he did with his might. But before he entered upon his work as a teacher and champion of evolution and general popularizer of science, he was destined to pass through a very painful period of his life—a period during which he

suffered from disease of the eyes, involving weary months and years of sometimes partial, sometimes total, blindness.

Altogether he struggled for fifteen years with this terrible disability, dating from the time when his eyes were first attacked in his fifteenth year. These years, however, were not years of idleness: when he could not see he could listen, and his sister, who was seldom far from his side, would read to him from any book he might indicate. Between being read to and reading for himself, when it could be done with any safety, he vastly increased his stores of knowledge, and particularly became so proficient in chemistry that he was able to produce a text-book which had immediate success, and which, in a revised form, is holding its ground to this day.

No sooner had he recovered a fair measure of sight than he betook himself to the delivery of popular lectures on scientific subjects; and here he seemed to have found his true vocation. The people heard him gladly, and more engagements were offered than he was able to accept. The work, however, was not without its dangers: the lecture season was of course in the winter, and in his journeyings to and fro Mr. Youmans was frequently exposed to chills, and was laid up more than once with severe bronchial and pulmonary attacks. If dangerous to the lecturer, the work was useful to the multitude. "Many a young man," observes his biographer, "in many a town could trace to Youmans and his lectures the first impulse that led him to seek a university education. In quarters innumerable his advice gave direction to family reading in the best treatises on astronomy, physics, chemistry, geology, and physiology."

It was not in the lecture field, however, that he was destined to do his most important work. In the year 1856 he saw in a periodical an article on Spencer's then recently published Principles of Psychology. He sent for the book, and saw, to use Prof. Fiske's words, that "the theory expounded in it was a long stride in the direction of a general theory of evolution." He then read Spencer's Social Statics, which had appeared a few years earlier, and, as we are told, "began to recognize Spencer's hand in the anonymous articles in the quarterlies in which he was then announcing and illustrating various portions or segments of his newly discovered law." Finally, in the year 1860, he was shown a copy of the circular in which Spencer was announcing his philosophical series. That such a man should be appealing for support, to enable him to bring out works of so transcendent importance, suggested at once to Mr. Youmans that here was a chance for him to render service which might be of much moment. He took what he felt at the time to be the bold step of writing to Spencer, and offering to interest himself in getting American subscribers to the series. Mr. Spencer replied, thanking him very warmly for the offer and for the sympathy which his letter had expressed; and thus was begun a friendship of the most sincere and enduring character between these two eminent men. Nothing in the volume before us is more interesting or produces a pleasanter impression that the extracts given from the correspondence which passed between them from this date onward to the death of Mr. Youmans.

The result of the acquaintance thus formed was that Spencer obtained a gratifying number of subscribers to his series in this country, and that the republication of his works was begun by Messrs. D. Appleton & Co., who were the publishers of Youmans's Chemistry and of another work which he had produced under the title of Handbook of Household Science. This was really the turning point in Spencer's fortunes. In one of his letters to Youmans we find the following passage: "The energy and self-sacrifice you continue to show in the advancement of my scheme quite astonishes me; and while, in one respect, it is very gratifying to me, yet in another it gives me a certain uncomfortable sense of obligation, more weighty than I like to be under." This shows the relations that had been established between the two men, and makes the action which Youmans so vigorously, we might say heroically, took at a later date to help his friend through a financial crisis entirely natural. Such he was to Spencer all through—the one untiring upholder of his name, defender of his views, and good providence of his fortunes on this continent. Spencer and the evolution philosophy were inseparable in his thoughts, and for so great a cause repre-

sented by so great a name no sacrifice was too great.

We are nearly at the end of our space, without, unfortunately, being nearly at the end of our subject. The travels of Mr. Youmans in England and on the continent of Europe, sometimes in the company of Spencer; his correspondence with members of his family in this country; his labors in arranging for the publication of the International Scientific Series, in connection with which he visited Paris, Berlin, and Leipsic, and came into personal relations with the leading *savants* of France and Germany; finally, his establishment of The Popular Science Monthly, chiefly on the strength of a series of original articles by Spencer, on The Study of Sociology, would admit of extensive and interesting treatment; but for all this we must refer our readers to the book itself. The aim of this notice has been to indicate to the many who knew Prof. Youmans only by name what manner of man he was, and what services he rendered in the cause of intellectual progress. Prof. Fiske, with the skill of an accomplished writer and the sympathy of an intimate friend and most sincere admirer, has given the finer as well as the broader lineaments of his character in a manner that leaves little to be desired. That so energetic a worker, with so capable a brain and so large a heart, should have died at the comparatively early age of sixty-five is a matter for profound regret, particularly as we are compelled to attribute it to the same want of care for his general health and over-devotion to work which brought on, and then aggravated, his early trouble with his eyes. As a writer Prof. Youmans had a style of his own, full of nervous force and grace—a style ample and rich, and yet admirably precise. Some of his essays are published as an appendix to the biography, and form most interesting and instructive reading. From these his dominant ideas and purposes may be gathered; and no one can read many pages without seeing and feeling that here was no intellectual dilettante, but a man with a mission, and that the lofty one of dissipating ignorance and prejudice, spreading the light of science, and preparing the way for those "nobler modes of life" of which seers have prophesied and poets sung.

THE GENUS SALPA. A Monograph, with Fifty-seven Plates. By WILLIAM K. BROOKS, Ph. D., LL. D. With a supplementary Paper by MAYNARD M. METCALF. Memoirs from the Biological Laboratory of the Johns Hopkins University. Vol. II. Baltimore, 1893. Price, $7.50.

THIS bulky quarto, with its companion volume of fifty-seven plates, is a monumental work. It is the result of years of concentrated effort, and is a credit to American science.

The subject of the investigation is a pelagic or free-swimming Ascidian, confined to the high seas, and exceptional even in a group whose larvæ are plainly allied to vertebrates, while the adults have lost nearly every resemblance to their vertebrate allies by the degeneration and loss of their vertebrate features. Salpa is aptly described by Prof. Brooks as a transparent swimming Tunicate, which in effect is "an enormous pharynx which swims through the water, gulping in great mouthfuls at each contraction of its muscles." Happily the supply of radiolarian and diatom food is unlimited, and hence Salpæ multiply in immense profusion and with astonishing rapidity.

Salpæ under favoring conditions of food, and perhaps other physical causes not discussed by the author, reproduce both sexually and asexually. Each species has two generations in its life-cycle, known as the solitary generation and the aggregated generation. Chamisso, the poet, novelist, and biologist, first discovered this. The solitary salpa is born from an egg which is carried within the body of the aggregated salpa, whose blood nourishes the embryo during its development by means of a nutritive placenta. On the other hand, the aggregated or chain salpæ are produced asexually by budding from the body of the solitary salpa.

This placenta, as Brooks shows, contrary to the views of some writers, has only a superficial resemblance to the fœtal organ of the mammals; it is an independent structure, being in the salpa only of use in conveying food to the embryo. This food has been discovered by the author to be great placenta cells which migrate from the body of the chain salpa into the body cavity of the embryo. Hence the embryo salpa stands in a much more direct relation to the external world than the mammalian embryo.

Space will not permit us to further notice the special points elaborated by the author, the table of contents alone occupying two crowded pages. The work is divided into four parts: I. A general account of the life-history of salpa. II. The systematic affinity of salpa in its relation to the conditions of primitive pelagic life; the phylogeny of the Tunicata; and the ancestry of the Chordata. III. A critical discussion of my own observations and those of other writers, on the sexual and asexual development of salpa. IV. On the eyes and subneural gland of salpa, is by M. M. Metcalf, who, among other points claims, contrary to Buetschli, that the eye of salpa is not homologous with the eye of any other chordate animal.

The general reader and biologist will be especially interested in the views presented in Part II. Brooks speaks of the wonderful scarcity of pelagic life in the lagoons and landlocked waters of the Bahamas, and explains it by the theory that the surface life is eaten up by the animals at the bottom, every organism swept in by the tides and every larva born in the sounds being eaten up by the polyps, etc., at the bottom, the competition for food being so fierce. He maintains that early in the Cambrian period, or when life first began, it was pelagic, or confined to the surface. Gradually some of the pelagic forms, at first minute and simple, settled at the bottom, and such a primitive bottom fauna was similar to the lower Cambrian fauna. This bottom fauna at first entirely depended for food upon the pelagic life at or near the surface, there being no plant life yet in existence. This primitive bottom fauna was established around elevated areas in water deep enough to be beyond the influence of the shore. He claims that the great groups of Metazoa, or all animals above protozoans, were rapidly established from pelagic ancestors. This, it may be said in passing, is in direct opposition to the view generally entertained that the pelagic fauna is derived from the shoal-water or shore life.

After the establishment of the first bottom fauna competition swiftly arose, became very rigorous, and led to rapid evolution, and "life on the bottom introduced many new opportunities for divergent modification and for the perfecting of animals." The increase in size of the animals also increased the possibilities of variation, and led to the natural selection of those peculiarities which increased the efficiency of different organs, and thus proved an important factor in the evolution of complicated organisms; the new modes of life—what they were, the author does not state, but they must have been in great part the results of fixation at the bottom, together with the operation of currents, etc.—permitting the acquisition of protective shells, or hard, supporting skeletons. Life at the bottom also introduced the factor of competition between blood relations, the fiercest competitors of each kind of animal being its closest allies, "which having the same habits, living upon the same food, and avoiding enemies in the same way, are constantly striving to hold exclusive possession of all the essentials to their life." Thus the tendency of such bottom forms was to divergent evolution of the great types of animal life. Since then, the author claims, "evolution has resulted in the elaboration and divergent specialization of the types of structure which were already established, rather than in the production of new types." This is all very likely, and, to continue the train of reasoning, the next great step was the origin of land animals, terrestrial and fresh-water arthropods, and the third great step was the evolution of animals, arthropod and vertebrate, adapted for life in the air. We may suggest that it was the Lamarckian factors of profound and widespread changes in the environment, such as a transfer of the habitat of animals from the surface to the ocean bottom which tended to increase and diversify life forms, together with the use and disuse of organs resulting from enforced adaptation to the new conditions. After all this had begun there comes in the more passive factor of natural selection, subordinate, though constantly at work, which further promoted the elaboration and specialization of organic forms.

LETTERS OF ASA GRAY. Edited by JANE LORING GRAY. In Two Volumes. Boston: Houghton, Mifflin & Co. Price, $4.

DR. GRAY was a delightful correspondent. He wrote with the easy manner and hearty tone that give letters their highest charm. In telling distant friends what he

is occupied with he presents no bare outline, but fills up his picture with a wealth of interesting details. And his good-natured fun is continually peeping out from some corner. The first group of letters concern various undertakings between the twenty-first and twenty-eighth years of his life, and are mostly addressed to his father and mother and to Dr. John Torrey. In them he speaks frankly of his plans and aspirations, saying in one place, "I am determined to persevere for a little while yet before I give up all hopes from science as a pursuit for life." His journeys by stage-coach and steamboat to various places in the State of New York and one to Detroit are graphically described. His account of his first journey in Europe, given in letters home which took the form of a journal, is also very graphic. We find in the early pages of this chapter enthusiastic references to twenty days of study among Sir William Hooker's botanical collections, closely followed by a description of Edinburgh and references to lectures by the famous men in its university. Here he does not neglect to note that Dr. Hope, who lectured on chemistry, "did not wear his gown or ruffles at the wrist," also that the class in anatomy "behaved shockingly, even for medical students." In London, through his letters of introduction and the good offices of Hooker and his son "Joe," who were there at the same time, Gray made many pleasant and useful acquaintances. Busy days those spent in the "modern Babylon" must have been, for a bewildering number of persons and places were visited. Proceeding to France, Dr. Gray made the acquaintance of Jussieu, Decaisne, Seringe, Delile, and other botanists. He then crossed Italy and visited parts of Austria, turned back through Switzerland and Germany, and finally sailed from Hamburg for London. His journal describes his meeting with the celebrated botanists of all the places visited, and contains the traveler's impressions of the usual "sights," besides notes of miscellaneous incidents of travel. The year in Europe is followed by a decade of work at home, in the early part of which Dr. Gray was appointed to the Fisher professorship in Harvard College, which he retained for the rest of his life. The letters of this period speak of work on Torrey and Gray's Flora of North America, the arrangements for the new labors at Harvard, and work on various publications. One of his first discoveries in Cambridge was that "there's nothing like Down East for learned women," and he gives instances. A second trip to Europe was made in 1850–'51; old friendships were revived and new ones made. One of the new friends was Charles Darwin, and a large part of the letters in the next division of this collection were addressed to him. The letters in the remaining divisions tell of new publications and revisions of old ones, the examination of collections and single specimens from all quarters of the globe, further journeys to Europe and elsewhere, and miscellaneous matters. One of the most valuable features of these two volumes are the opinions and bits of information about prominent botanists that are scattered through them. Prof. Gray was not oblivious to affairs of moment outside the field of botany; thus his letters during the time of the civil war contain many vigorous comments upon passing events, and we are informed in a foot-note that he enlisted and drilled with a company raised for service in Massachusetts. He was then over fifty years of age. The playful turns of thought already referred to are frequent. Now the subject is the German feather-stuffed bedcovering, again it is the simian ancestry implied in Darwin's books, but nothing is more delightful than the burlesque botanical description of the piece of wedding cake that he sends to the Torreys. The two volumes contain three portraits of Dr. Gray, a picture of him in his study, and a view of the range of buildings in the Harvard Botanic Garden. A brief autobiography prefixed to the first volume gives an account of Gray's ancestry and his early years.

A Class in Geometry: Lessons in Observation and Experiment. By George Iles. New York and Chicago: E. L. Kellogg & Co. Pp. 46. Illustrated. Price, 25 cents.

"Can dry bones live?" is apt to be one's thought in taking up a book on lines, surfaces, and angles. That the dry bones of geometry *can* live Mr. Iles proved to the readers of The Popular Science Monthly in November, 1890. He then told in part a story which here is told in full. Taking an

informal class of three boys, he led them to observe their common surroundings—fields and farms, buildings and machinery, plants and insects—bringing out their embodiment of laws of form and size of the widest sweep. Breaking a live coal into fragments on a hearthstone, his pupils saw that the smaller a lump the sooner it cooled and turned black; step by step they discovered that the moon, the earth, Jupiter, and the sun, from their relative magnitudes, are in the same case—are but cinders, or cinders in the making. Simple models, easy to reproduce, served in other lessons—an inverted wedge gradually withdrawn from immersion in a jar half full of water became an extractor of square root; an inverted cone, similarly treated, was employed as an extractor of cube root. A diagram, which has only to be seen to be understood, enabled his class to perceive that the surface of a sphere is equal to the curved surface of the cylinder which incloses it, and hence is equal to the rectangle which the cylinder describes in being rolled round once on a plane. Mr. Iles abundantly exemplifies the inventiveness which he recommends as an element in making a lesson stick to a pupil's mind. On the very threshold of Euclid he has come upon novel and important implications of the elementary laws of space; he has thence opened new paths of approach to the study of mechanics and physics. A distinctly refreshing note is struck in illustrating that not the immediate but the total indications of geometry point the way to the constructor; that if calculation is to be just, it must be directed with judgment. This little book can be as helpful to the teacher as that other unconventional aid, William George Spencer's Inventional Geometry.

White's New Course in Art Instruction. Manual for the Fifth-year Grade. New York, etc.: American Book Company. Pp. 112. Price, 50 cents.

White's New Course in Art Instruction embodies the ideas of many teachers, who, starting at different points and working along different lines, arrived at the same conclusions. Its aims are, first, to acquaint pupils with the rudiments of all kinds of drawing included under the two departments, mechanical and free hand; secondly, to lead pupils to feel that, while art and love for the beautiful may be fostered by an artistic and beautiful environment, skill and power and quick original perception of beauty come only through faithful and persistent practice in drawing; and, thirdly, to develop a love for the beautiful in Nature and art. The fifth year or grammar course includes the study of measurement, geometry, writing, drawing, development, color, historic ornament, botanical drawing, design, paper-cutting, and model and object drawing. Each subject is logically pursued throughout the grade, and each subject supplements others in the grade. The book abounds in each department in practical directions, concisely and perspicuously given, to which the illustrations, clearly and accurately drawn, are a real help.

Symbolic Education. A Commentary on Froebel's Mother Play. By Susan E. Blow. New York: D. Appleton & Co., 1894. International Education Series. Pp. 251. Price, $1.50.

The advent of the kindergarten in the educational system of this country has great significance, and statistics show a steady increase in kindergartens, teachers, and pupils.

Symbolic Education, by Susan E. Blow (Appletons' International Education Series), discusses practically the foundation of Froebel's philosophy in Mother's Play and Nursery Songs.

The editor, Dr. Harris, says the kindergarten inspires its teachers with the true missionary spirit, to devote themselves to the work of unfolding the self-activity of humanity in its feeblest and most rudimentary stage of growth. The teacher of advanced pupils does not need such refinements of method to secure profitable industry—it is the teacher of feeble-minded adults, or of very young children, that must have what the Germans call a "developing method." The good kindergartner continually follows Froebel by directing the pupils' own efforts without stunting them by officious help. Mothers should take heed of the warning that overcultivation of verbal memory cripples alike the power of original thinking and accurate observation. He says that the first self-revelation of the child is through play. He learns thus what he can do—what he can do easily at

first trial, and what by perseverance and contrivance. The child is naturally always outgrowing his playthings, always exhausting the possibilities of a given object to symbolize occupations and deeds of grown-up humanity about him. Were the child to arrest his development and linger contented over a doll or hobbyhorse, the result would be lamentable. Hence *unmaking* is as important as making, destructive energy is as essential to him as power of construction—a point often missed by kindergartners who have not penetrated Froebel's inner connection. This ideal of play material is realized in his gifts. Play must be purified by rational insight. From insight into the deep meaning that lies hid in childish play, there is but a step to its use in education. The manifold errors of kindergartners can be avoided only by clear insight into Froebel's aim—development of creative activity—and his kindergarten gifts are the practical response to the cravings of childhood. Rousseau's idea of atomism is criticised in contradistinction to *Gliedganzes*—"member whole"—man as a self-determined individual yet a constituent of a social whole. This, Dr. Harris says, "is undoubtedly the deepest and most fruitful idea in the philosophy of education, and the key to the practical work of Froebel—the source of that symbolism which is his most original contribution to educational science. . . . Rousseau's significance in education lay in opposing established institutions. He failed to see the revelation of human nature in social combination and thus missed education's chief aim. His Émile (Appletons') made educators recognize the sacredness of childhood. Its study is necessary to explain Pestalozzi, Froebel, etc."

Important considerations are offered in opposition to Rousseau's suggestions concerning exercising the senses and restraining the mind's activity. To develop quick perception, it is necessary not only to exercise the senses but to increase the pupil's stock of general ideas, and thus illuminate the mind that uses the senses. Environment and absorption of ideas from harmonious surroundings follow as important in child-education.

Pestalozzi is quoted as having struck the keynote of educational reform: "Nature develops all the powers of humanity by exercising them; they increase with use." Misuse is not use—not all exercising is developing. "The child that walks too soon deforms its legs." Exercise must be proportioned to strength to increase strength. Remarks upon education dealing with powers only as they become explicit are exceptionally strong. "Notwithstanding all that has been said and written, we still make knowledge our idol, and continue to fill the child's mind with foreign material, under the gratuitous assumption that at a later age he will be able, through some magic transubstantiation, to make it a vital part of his own thought. This is like loading his stomach with food which he can not digest under the delusive hope that he may be able to digest it when he is a man. . . . But glaring as are our sins of commission they pale before our sins of omission, for, while we are forcing upon the child's mind knowledge which has no roots in his experience, or calling on him to exercise still dormant powers, we refuse any aid to his spontaneous struggle to do and learn and be that which his stage of development demands."

This book is emphatically one for mothers, as it presents the subject of early child-training in a thoroughly practical manner.

THE PSYCHOLOGICAL REVIEW. Edited by J. MCKEEN CATTELL and J. MARK BALDWIN, with the Co-operation of Alfred Binet, John Dewey, H. H. Donaldson, G. S. Fullerton, William James, G. T. Ladd, Hugo Munsterberg, M. Allen Starr, Carl Stump, and James Sully. Published bimonthly by Macmillan & Co., New York. Pp. 112. Price, 75 cents; $4 a year.

THE leading and principal article in the first number of this periodical, January, 1894, is the presidential address of Prof. George T. Ladd before the New York meeting of the American Psychological Association, in which, while the science of psychology is confessed to be embryonic in its present stage, it is claimed that more opportunity is afforded on that account for students and investigators to contribute something important to its more stable and higher evolution. Three classes of inquiries are suggested, embracing the relation in which the statistical and experimental investigations stand to the total science of psychology, the relation in which the science stands to what we call

philosophy, and the relation in which it stands to conduct and to the practical welfare of mankind. Following the discussion of these questions is the speaker's expression of the conviction that the more he studies and teaches the science the deeper the impression that it is able and destined to contribute greatly to the welfare of mankind—by contributions toward the improvement of the art and practice of teaching; to the science and practice of medicine, especially in the department of neurology; to the diagnosis and treatment of the insane, the incorrigible, and the idiotic. "In general, why should we not expect to see our science contributing to the improved conduct and character of men in the school, in the court-room, the prison, and the asylum," to the work of the religious teacher and the mother? This address is followed by a study of the case of John Bunyan, by Josiah Royce; Studies from the Harvard Psychological Laboratory, by Hugo Munsterberg; shorter contributions on Arithmetic by Smell, by Francis Galton; The Psychology of Infant Language, by John Dewey; Work at the Yale Laboratory, by E. W. Scripture; Discussion of Works by Prof. Wundt and Mr. James Ward; and notices of psychological literature.

THE CANADIAN ICE AGE: Being Notes on the Pleistocene Geology of Canada, with Special Reference to the Life of the Period and its Climatal Conditions. By Sir J. WILLIAM DAWSON. Montreal: William V. Dawson; New York: Scientific Publishing Company. Pp. 301.

THE subjects discussed in this book have occupied the attention of the author to a greater or less extent since 1855, and he has published from time to time several papers and one pamphlet—Notes on the Post-pliocene of Canada—upon it. The present book is an attempt to collect in a convenient form the large mass of information included in the papers bearing on the history of the northern half of the continent of North America during the Ice age. Not satisfied with undertaking to explain the widespread and complex glacial formations of Canada by one dominant cause, the author is convinced that we must take into account the agency of both land ice and sea-borne ice in many forms, along with repeated and complex elevations and depressions of large portions of the continent. He is disposed, however, to seek for the causes of changes in climate rather in geological and geographical agencies than in astronomical vicissitudes. He notes the fact that no change, even of varietal value, has taken place in species since the beginning of the Pleistocene period as one of extreme significance with reference to theories of the modification of species in geological times. While not attempting to extend his generalizations south of Canada, he warns geologists in our country who insist upon portentous accumulations of ice within its territory, "that the material can not be supplied to them from Canada. They must establish gathering grounds within their own territory."

FIRST LESSONS IN CIVIL GOVERNMENT. By JESSE MACY. Boston: Ginn & Co. Pp. 229. Illustrated. Price, 70 cents.

THE expansion in the sphere of government in the United States has far outstripped popular education in the duties of citizenship. This undoubtedly is one of the causes of the current failure in government, deplored in every State and Territory of the Union. Hence the incalculable value of instruction such as Prof. Macy's, which takes boys and girls just as they are and interests them in the affairs of their county and State and the nation. Our author maintains that when a child is drawing a map of its township it readily comprehends that a township elects officers and cares for the highways; so, also, when drawing a map of its county and State it can easily understand that these are not mere pieces of land, but that they represent governments as well. Beginning with the public school which a child is attending, the government of the school district is shown as linked to that of the State; next, the county governments are studied in their various forms. As typical States, Prof. Macy has selected Massachusetts, New York, Pennsylvania, and Virginia; the government of each is described, and the governments of all four are compared; provision is made for the study of any other State government. Lastly, the Government of the United States is briefly explained. Thus, with the practiced hand of a teacher for many years successful in this branch of education, Prof. Macy begins

at the home acre, that he may the better end by inculcating an intelligent patriotism which regards the whole country. In his concluding chapters he passes from exposition to appeal. He shows how much government means in modern life, and insists, none too strongly, on the necessity that government be purified. He declares that millions of citizens stand ready to die for their country who refuse to make the daily sacrifice of time and comfort demanded for the honest and competent discharge of public trusts.

Civic virtue, indeed, is no mere plaint of the moralist, it is the sole condition upon which scientific advance can come to its fruitage—upon which public health and safety can be enjoyed. America, for example, lags far behind Europe in civic engineering, simply because to extend the scope of municipal administration would but widen the field for official incapacity and corruption.

THE WILDER QUARTER-CENTURY BOOK: ORIGINAL SCIENTIFIC PAPERS, DEDICATED TO PROF. BURT GREEN WILDER. By some of his Former Students of Cornell University. Ithaca, N. Y.: Comstock Publishing Company. Pp. 493. Price, $5.

No more graceful tribute could well be conceived nor ample volume designed for the purpose intended than The Wilder Quarter-Century Book—1868–1893. In fact, seventeen of Prof. Wilder's former Cornell pupils, who have since become more or less famous in sundry scientific departments, have joined hands and pens in dedicating to their worthy professor anything but a perfunctory work. This assumes the form of a collection of papers on physiological subjects, including vertebrate zoölogy and neurology. Their dedication to Prof. Wilder, B. S., M. D., is declared as "a testimonial of their appreciation of his unselfish devotion to the university and in grateful remembrance of the inspiration of his teaching and example." The book itself is well printed and profusely illustrated, several excellent plates being noticeable throughout. A finely executed portrait of Prof. Wilder by John P. Davis, Secretary of the Society of American Wood Engravers, constitutes the frontispiece. The President of the Leland Stanford Junior University, David Starr Jordan, LL. D., contributes the first article—Temperature and Vertebræ: a Study in Evolution—which discusses with clearness the relations of the numbers of vertebræ among fishes to the temperature of water and the character of the struggle for existence. An essay by John Henry Comstock, B. S., Professor of Entomology and General Invertebrate Zoölogy in Cornell University, on the application of the theory of natural selection in the classification of animals and plants, illustrated by a study of the evolution of insects' wings, completes another important paper. The Vital Equation of the Colored Race and its Future in the United States is contributed by Dr. Rollin Corson, B. S., and Theobald Smith, Ph. B., M. D., Professor of Bacteriology and Hygiene in Columbian University, Washington, D. C., treats of the Fermentation Tube, with special reference to anaërobiosis and gas production among bacteria. Muscular Atrophy is considered as a symptom by Dr. William Krauss, B. S.; and Prof. Biggs, M. A., M. D., of Bellevue Hospital Medical College, invites the reader to a bacterial study of acute cerebral and cerebro-spinal lepto-meningitis. An interesting and important essay is that by Veranus A. Moore, B. S., M. D., of the United States Department of Agriculture, on the character of the Flagella on the Bacillus Choleræ Suis; while Grant Sherman Hopkins, D. Sc., of Cornell University, unfolds the nature of the lymphatics and enteric epithelium of *Amia calva* The instructor of vertebrate zoölogy in Cornell University, Pierre Augustine Fish, B. S., adds a highly thoughtful paper on Brain Preservation, giving a *résumé* of some old and new methods.

While other essays of import go to make up the work, the engravings of moths and some fine plates by Anna Botsford Comstock, B. S., natural-history artist, may, from an art point of view, be regarded as possessing a high order of merit. Preceding a table showing the courses given by Prof. Wilder, we obtain also an intimate acquaintance with Dr. Wilder's numerous and miscellaneous writings from 1861 to 1893. These include published works, essays, papers read, and many important reviews. The volume before us lacks nothing in completeness and the style throughout is clear, very often fascinating, and always of varying importance. Within certain limitation, the work will

serve as a valuable adjunct in every student's library.

In continuation of the archæological work of the late Prof. *Eben Norton Horsford*, his daughter, Miss *Cornelia Horsford*, has published together a paper by her father entitled *Leif's House in Vineland* and one by her on *Graves of the Northmen* (Damrell & Upham, Boston). The former describes excavations made by Prof. Horsford in Cambridge on the site of a dwelling which he identified as one built by the Norse discoverers of America, the latter describes similar excavations made by his daughter on the site of a similar dwelling near by. Among the discoveries on these spots are parts of the foundation walls, fireplaces, charcoal, shells of mollusks, and the teeth and bones of a deer. Miss Horsford has also opened two grave mounds, but has not opened what she thinks may be the grave of Thorbrand the Valiant, preferring to leave this work to an experienced archæologist.

An *Iowa Geological Survey*, apparently the third one, was organized in 1892, and has issued its *First Annual Report*. The most extended paper in this volume is a general account of the Geological Formations of Iowa, by Charles R. Keyes, the Assistant State Geologist. There is an account of Cretaceous Deposits of Woodbury and Plymouth Counties, by the State Geologist, Samuel Calvin, a Catalogue of Minerals, and papers on Limestones and Lava Flows. Ten plates and twenty-six cuts illustrate the text. A bibliography of two hundred and fifty pages included in the volume shows that its field is not an untrodden one.

Whenever a public library is started one of the first and most important tasks of its managers is to make up a list of books as the foundation of the collection. Most of the labor of this task could be saved in every case if a carefully made list were obtainable that need only be slightly changed so as to fit it to the requirements of the library in question. At the Columbian Exposition the American Library Association exhibited a popular library of five thousand volumes, in which were illustrated the most approved methods of shelving, cataloguing, and issuing books. A catalogue of this collection has been issued by the Bureau of Education, under the title *Catalog of A. L. A. Library*, and is designed to serve the purpose of a list the need of which is indicated above. The committee in charge of the work does not claim that the A. L. A. Library is an ideal selection, but that it is a good working library, and that no board of trustees would make a mistake in duplicating it. The Catalog really contains two catalogues of the books selected—one arranged according to the Decimal system, the other according to the Expansive system. The books in the classes of fiction and biography are not given in the classed catalogues, but in separate alphabetical lists. A large proportion of the books exhibited were given by their publishers. The collection was to be, and probably now has been, deposited with the Bureau of Education at Washington, for permanent exhibition. The selection of the A. L. A. Library might be criticised as better adapted to a community of students than to the users of the ordinary popular library. Seventy-five to eighty per cent of the circulation of every popular library is fiction, but only a fraction over fifteen per cent of the books in this collection is fiction. This library tries to cover all fields of knowledge fairly well, and what it shows is not so much what the average reader would want as what he ought to want.

The *Report of S. P. Langley, Secretary of the Smithsonian Institution, for the Year ending June 30, 1893*, presents briefly a general account of the Institution, and in the appendixes summaries of the reports of the officers in charge of the National Museum, the Bureau of Ethnology, the Bureau of International Exchanges, the Zoölogical Park, and the Astro-physical Observatory.

Several numbers of *Aëronautics*, a monthly journal devoted to the subject indicated by its name, have been received since last October, when it was established by M. N. Forney, publisher of the American Engineer and Railroad Journal and various engineering books (47 Cedar Street, New York, $1 a year). It is to contain in twelve numbers the papers presented to the Congress of Aërial Navigation held during the World's Fair, besides other articles, notes, comments, news, etc. Among the papers contained in the first four numbers are On the Problem of Aërial Navigation, by the

late C. W. Hastings; The Internal Work of the Wind, by Prof. S. P. Langley; and Exploration of the Upper Atmosphere, by N. de Fonvielle. A large illustration occupies the first page of each number—that in the first number shows an English military balloon, that in the second the Maxim flying machine.

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POPULAR MISCELLANY.

Studies of Lakes.—Lakes, says Mr. Albert P. Brigham, belong within the domain of what is sometimes called geographical geology. Their geographical interest is not small. Their variety in size, from the smallest natural ponds up to inland seas, their diversity in shape, depth, and altitude, and their great numbers, are facts which strike the attention and suggest inquiry. Studied geologically, lakes open up an important body of facts. Primeval continents could not have progressed far in their growth before lake-making conditions began to appear. Viewed individually, lakes are affairs of short life. Geological forces are always making lake basins, and such basins are constantly being destroyed by filling with sediment, or by the cutting down of their rims; or, the basin may remain, while the lake is destroyed by desiccation. On most competent authority, the numerous lakes of the Scottish Highlands are but a fraction of what have formerly existed. The variety of forces whose action aids in bringing lakes into being has suggested the most convenient classification of lakes—that is, according to their origin. Thus we have a relatively small group of lakes of volcanic origin, occupying old craters or valleys obstructed by lava. More important is the group of orographic lakes, or those due to deformation of the earth's crust. Here belong the lakes of the Great Basin. In limestone countries, solution lakes are not uncommon, and this agency has been operative in enlarging many basins due primarily to other agencies. Landslip lakes have been noticed by Lyell, and Gilbert records the formation of small lakes behind landslip terraces. River and shore lagoons must be named in any full classification, while glaciation, in one way or another, is responsible for the existence of most lakes. Here we have the ice-dam or temporary type, as Agassiz and Iroquois, the kettle-hole group, which is often made to include what Geikie calls "Lakes of the Plains," and which he defines as lakes that "lie in hollows of the covering of detritus left on the surface of country when the ice-sheets and icebergs retreated." Thus they differ from the kettle-hole ponds, which are thought to have frequently originated by the sliding of *débris* from stranded bergs or ice masses isolated by retreat of the main sheet. Other glacial lakes are due to morainic dams in valleys, and yet others are in whole or in part rock basins, due to glacial excavation; of these are the lakes of New York.

The Beginnings of Speech.—André Lefévre, in his book on Races and Languages, postulates as the origin of speech that the animal is already in possession of the two significant elements of language: the cry, spontaneous and reflexive, of emotion and need; the cry, already intentional, of warning, menace, and appeal. From these two sorts of cry man, endowed with a richer vocal apparatus and less limited cerebral

faculties, has derived numerous varieties, by prolongation, duplication, and intonation. The cry of appeal, the germ of the demonstrative roots, prelude to nouns of number, sex, and distance; the emotional cry, of which our simple interjections are survivals, combining with the demonstratives, prepares the outlines of the proposition, and prefixes the verb and the noun of condition and action. Imitation, either direct or symbolical, but necessarily only approximative, of the sounds of Nature, or, in short, onomatopœia, furnishes the elements of attributive sorts: from which proceed the names of objects and special verbs and their derivatives. Analogy and metaphor complete the vocabulary by applying to objects of touch, sight, smell, and taste the qualifications derived from onomatopœia. Then comes reason, which, discarding the greater part of this unwieldy wealth, adopts a larger or smaller number of sounds reduced to a vague or generic sense; and by derivation, suffixing, and composition cause to proceed from these subroots indefinite lineages of words, having every manner of relationship among themselves, from the closest to the most dubious, and which grammar proceeds to distribute among the recognized categories of parts of speech.

The Audubon Monument.—The Monument in memory of J. J. Audubon, erected by the Audubon Monument Committee of the New York Academy of Sciences, consists of a granite base, a bluestone die, and a cross, and is in all twenty-five feet ten inches high. It is adorned with figures of the birds and animals which Audubon described. In raising the money for it, Prof. Thomas Egleston says, at first school children took a great interest in it individually, and many subscriptions were received from schools as the contributions of the children. Some subscriptions were sent in postage stamps, others as low as ten cents were received from every part of the United States. After a number of months it was found that by this method a sufficient sum for the erection of the monument could not be raised. It was then proposed to ask a hundred gentlemen in the cities near New York in which Audubon had been especially interested to give a hundred dollars each, and this plan succeeded so well that the amount was raised in the fall of 1891. The contributions for the monument were received from almost every part of the United States. Boston was very liberal; Philadelphia and Baltimore made some subscriptions; but much the largest part was contributed by citizens of New York city. The small balance which remains is to be invested as "the Audubon Publication Fund," the interest of which is to be devoted to the publication of a memoir on some zoölogical or botanical topic, annually, or whenever a paper suitable for such memoir shall be presented.

Experiments with Liquid Oxygen.—By means of the intense cold produced in his experiments in liquefying gases, combined with an exhaustion not before attained, Prof. Dewar has proved that mercury distills, as do phosphorus and sulphur, at the ordinary temperature when the vapor pressure is under the millionth of an atmosphere. The increasing indisposition shown by the chemical elements to combine with one another as the absolute zero is approached was well illustrated in an experiment in which liquid oxygen was cooled to — 200° C. On inserting a glowing piece of wood into the vessel above the liquid it refused to burst into flame. Another interesting experiment was that of immersing an electric pile composed of carbon and sodium into liquid oxygen; almost immediately the electric current ceased, in consequence of the suspension of chemical action. Absolute alcohol, run upon the surface of liquid air, after rolling about in the spheroidal state, suddenly solidifies into a hard, transparent ice, which rattles on the sides of the vacuum test-tube like marble. On lifting the solid alcohol out by means of a looped wire the application of the flame of a Bunsen burner will not ignite it. After a time the solid melts and falls from the looped wire like thick sirup.

Mountains and Lakes.—The first of Sir Douglas Freshfield's Christmas lectures before the Royal Geographical Society was on mountains in their relation to the earth as a whole, and more particularly the peculiar features of snow mountains. Mountains, however great in human eyes, the lecturer said, were mere wrinkles on the face of the earth. How were they made? was a natural

question for a child to ask, but one which men of science hesitated in answering. When did the moraines come that rise like railroad embankments among the orchards and cornfields of Savoyard valleys? Was their material excavated by the moving ice, or did the ice serve as a sledge to transport the rocks that fell from the peaks and ridges around them? The matter was one capable of direct observation. It was not the largest glaciers that had the greatest moraines, but rather those that lay under lofty ridges, and particularly those where the surrounding rocks were specially subject to disintegration by weather. He agreed with those who regarded glaciers as polishers rather than diggers, and drew a distinction between abrasion and erosion. The formation of lake basins could be accounted for without the agency of ice. In fact, lake basins did not occur where they ought to, if the theory of formation by erosion was correct. Alpine towns occupied basins which had not been dug out by glaciers, but preserved by a frozen covering from being filled up by the action of torrents. Snow and ice protected the ground they covered from disintegration by ice and floods. At the same time subglacial torrents performed singular feats in cutting deep and narrow rock channels, and thus contributed to the soil they carried. The color of their water was, however, mainly due to the fineness of the particles of the mud derived from the grinding of the bowlders subjected to the glacier mill. In winter the water that flowed out of a glacier was clear. It was supplied, not as had been supposed, by the continual melting of the ice, but was the issue of subterranean springs in the glacier's bed.

Running Amok.—The condition under which the Malays run *amok*, as described by Dr. Ellis, of the Government Hospital, Singapore, in the Journal of Mental Science, seems usually to be preceded by a period of mental depression, sometimes with suspicion, and the patient, when he breaks out, slashes at, stabs, and sometimes mutilates all who come in his way, irrespective of creed or nationality. The weapons used are a short spear, a Malay *kris*, or a chopper, and in the old days—even now in the uncivilized parts of the peninsula—it was the custom to have long, forked sticks, which were used against the man who was running *amok*, to stop him and pin him to the ground. Such men, when caught, are now tried regularly and sent to an asylum; but formerly little mercy was shown them, and they were killed at once, as though they were mad dogs. The condition seems to resemble in many particulars the automatic condition which is sometimes left after an epileptic fit; this, in some cases, takes the form of running, or "procursive epilepsy"; and, if we imagine such a patient armed with a knife and imbued with a homicidal impulse, we have practically all the conditions necessary for the Malayan pathological development. The Malayan, in his sound state, professes to have no recollection of the assaults he has committed. The condition of running *amok* is becoming less common than it was a few years ago.

Leaves and Rain.—Mr. E. Stahl, says Garden and Forest, has been making a study of leaf-forms in relation to the rainfall, chiefly in the Botanic Gardens of Buitenzorg, and he says that while a large leaf-surface partly provides for the removal of water by transpiration, there are other distinct methods by which plants are helped to dispose of any excess of water accumulating upon them as speedily as possible. One of these is the adoption of the sleeping position by leaves, such as those of the sensitive plant, so that when the horizontal leaves bend upward the raindrops run off by the base of the leaf. Most frequently, however, excessive moisture is drained off by long points to the leaves. These points occur on the lobes of divided leaves, but are most remarkable on long ovate leaves. In some plants the prolonged midrib has the form of a wide channel, but generally it is that of a tapering and narrow point, slightly curved ot the end. As the water trickles down the inclined narrow points it passes from the upper to the under surface before dropping from the leaf, and the bent tip accelerates this action. Stahl tested this theory by experiments, and found that the leaves of *Justicia picta* which he carefully rounded retained moisture for an hour, while those with the dropping points left on were dry in twenty minutes or less. This rapid remova of water from the leaf lightens its weight,

helps transpiration, and cleanses the surface. In verification of this we are reminded that after a shower the pointed leaves of the ash, willow, etc., have had the dust quite washed out, while rounded leaves like those of the oak are still dirty.

Timber Testing.—From the Report of the Division of Forestry for 1893 we learn that the scheme of testing timbers to determine their several qualities has found general favor in this country and in the Old World too. The calls for special investigations into the qualities of various kinds of timbers have been numerous, and beyond the financial ability of the division to attend to them all. A special demand exists for the tests of kinds that are still more or less unknown, they being now drawn upon to eke out the deficiency of supply of the better-known kinds. The collections of test material had reached, at the time of preparing the report, a total of two hundred and thirty-four trees. A series of tests and examinations of bled and unbled timber has been carried on in order to ascertain whether the practice of taking the resin from trees has any influence on its quality. The results seem to show that there is no determinable influence upon the mechanical properties of the timber. But the removal of the resin, if not carried on with care, affects the life of the tree and invites other destructive influences. The turpentine industry, like the lumber industry, is carried on on the "robbing system" of taking off in the most crude and rapacious manner what Nature has provided. It is time, Prof. Fernow maintains, to substitute a "management system," which shall utilize the remaining resources more exhaustively yet more carefully, by avoiding all unnecessary waste.

Madagascar Lemurs.—The great island of Madagascar, with a surface extent exceeding that of Italy, is, like Australia, a land by itself, with a fauna distinct from that of Africa. This fauna is particularly characterized by the presence of numerous lemurians or *maki* mammals, which are also called false monkeys, or fox-nosed monkeys, and which occupy a corresponding place with the monkeys of Africa. A few lemurians are found in Africa and Malaysia, but they appear to be isolated there, and like estrays among a fauna of different character. There still exists on this island a singular cat called the *Cryptoproctus*, which is plantigrade (sole-walking), while all the other cats in the world, excepting Australia, are digitigrade (toe-walking). Such zoölogical peculiarities give this island as nearly a marked stamp of strangeness as that by which Australia is distinguished. To find a fauna comparable to this we have to go back to the ancient geological periods and question the fauna characterizing them. We find that animals similar to those living in Madagascar inhabited the forests of France in the Eocene and Miocene ages of the Tertiary. Vestiges of an animal but little different from the *Cryptoproctus* of Madagascar have been found in these formations, and the remains of tree-living lemurians allied to the *makis* of Madagascar have likewise been found in them. Thus Madagascar yet supports a Tertiary fauna, as Australia is still the home of a Cretaceous fauna. The investigation of the fossil fauna of the country becomes, in the light of these facts, a matter of much interest. It has hardly been begun as yet, but has yielded some remarkable specimens. Among them are the eggs and bones of the largest of all the birds known—the *Epiornis*, sixteen feet high—a hippopotamus very different from those now living, and the skull of a great lemurian which has been described by Mr. Forsyth Major as *Megaladapis madagascariensis*. The lemurians now living in Madagascar are only of medium size or small. The largest of them is the short-tailed *indri*, which is but little more than three feet high when standing erect on its hind legs. The *Megaladapis* was three times as large, or about the size of the orang-outang or the gorilla.

Mrs. Hemenway's Work for Science.—Mrs. Mary Tileston Hemenway, who died in Boston March 6th, seventy-two years of age, was equally famous for her benevolence and for her practical interest in promoting scientific work. Possessed of a fortune now valued at $15,000,000, she contributed half of the $200,000 that were raised to save the old South Church from destruction; projected an institute for the encouragement of the study of American history among young peo-

ple, of which Mr. John Fiske was for several years a principal lecturer; established a school for poor whites at Wilmington, N. C.; contributed to the support of the Hampton School, and founded a school at Norfolk, Va.; maintained sewing and cooking schools and schools of gymnastics in Boston; kept the Hemenway exploring and archæological expeditions at work in Arizona and New Mexico, which have borne fruit in the admirable researches of Mr. Cushing, Mr. Bandelier, and others; and was a liberal contributor to the funds of the American Archæological Institute, and patroness of Dr. J. Walter Fewkes's Journal of American Ethnology and Archæology. By her will the net income of her estate, after certain specified payments are made, is to be appropriated for fifteen years to the support and furtherance of the objects in which she was interested. Persons engaged in archæological work at her expense are to be continued in it, as long as the results warrant it, on the same terms. At the end of fifteen years her collections—archæological, historical, and educational—are to be disposed of at the discretion of her executors. Among the specific bequests is that of the Lowry farm, adjoining the Hemenway farm, Virginia, to the Hampton Institute.

Herr Lilienthal's Flying Machine.—A communication from Prof. Du Bois-Reymond to the Physical Society of Berlin concerning Herr Lilienthal's experiments in aviation relates that in studying the flight of birds that gentleman perceived that flight was possible under conditions when the wind gave a vertical component. Experiments have shown that surfaces may acquire a horizontal motion under the action of the wind alone, provided their curvature is in a relation to the surface that corresponds exactly with that observed in birds. Herr Lilienthal's flying machine consists of a surface of suitable curvature, measuring fourteen square metres, and made of canvas stretched over a light wooden frame. At the center is an opening for the body of the experimenter, who keeps the apparatus up by working his arms. The author had seen Herr Lilienthal fly with his apparatus about one hundred and twenty metres a minute at thirty metres above the ground. With a favorable wind the experimenter could fly two hundred or three hundred metres; and Prof. Du Bois-Reymond had himself flown twenty or thirty metres with it. In the author's view the definitive solution of the question of flying machines depends upon three points—viz., judicious utilization of the wind, suitable form of surface, and skillful handling of the apparatus.

Odd Barometers.—Two of the oldest and oddest forms of popular barometers, says a writer in the London Spectator, are the leech in a bottle and a frog on a ladder. Mr. Richard Inwards has seen an old Spanish drawing of nine positions of the leech, with verses describing its attitude and behavior before different kinds of weather. Dr. Merryweather, of Whitby, contrived an apparatus by which one of twelve leeches confined in bottles rang a bell when a "tempest" was expected. When leeches were kept in every chemist's shop, and often in private houses, their behavior was the subject of constant observation; and it was generally noticed that in still weather, dry or wet, they remained at the bottom, but rose, often as much as twenty-four hours in advance, before a change; and, in case of a thunderstorm, rose very quickly to the surface, descending when it was past. The frog barometer, used in Germany and Switzerland, is a very simple apparatus, consisting of a jar of water, a frog, and a little wooden step-ladder. If the frog comes out and sits on the steps, rain is expected. The weather-glass dearest to the old-fashioned cottage in the last generation was the "old man and old woman," who came out of their rough-cast cottage in foul or fair weather respectively. This was almost the earliest of semi-scientific toys, and depended on the contracting of a piece of catgut fastened to a lever. The belief that bees will not fly before a shower is probably true, and is the rational origin of the banging of trays and iron pots with a door-key when bees are going to swarm. The insects are supposed to take this for thunder, and so settle close at hand, instead of swarming at a distance. Squirting water on them with a garden syringe often makes them settle at once. But no such ingenious process of rationalizing can be found for the belief that if the insect inside cuckoo-spit lies head upward, the summer will be dry, though the

increased worrying of horses by flies before rain, and the rise of the gossamer before fine weather, are abundantly confirmed by observation.

Habits of Birds.—Many interesting notices, local and general, respecting birds are to be found in the Abstract of the Proceedings of the Linnæan Society of New York for the year ending March 1, 1893. Frank M. Chapman, reporting at one of the meetings on the summer bird life of New York and vicinity, said that 127 species might be classed as summer residents, of which 108 were land birds and 19 water birds; 22 species might be considered abundant, 47 common, 31 tolerably common, and 27 rare. Dr. C. S. Allen contributed at another meeting an account of a breeding-place of pelicans on an island of Florida, a hundred and fifty feet long by fifty feet broad, and covered with a dense growth of mangroves. The nests were in bushes, ten or fifteen feet from the ground, were made of sticks, straw, dry weeds, etc., and held from one to four eggs. The young, on emerging from the shell, are of a size corresponding with that of the egg, and slate-colored, from tint of skin, with apparently scattering hairs (casings) protecting white down; but in a few hours they appear to have increased to several times the bulk of the egg, and become white as soon as the down is freed from the protective covering; in a few days they are as large proportionately as birds usually are when a week or two old. The increase in size is due, in part, to the power the birds have of taking air into the spaces beneath the skin which is very loose and capable of being immensely inflated. They remained in the nest only a few days, and thereafter rested on the surrounding bushes. Mr. Chapman instanced a number of cases of protective coloration, notably that of a flock of parrots flying into a palm tree, whereupon they became almost indistinguishable from their surroundings, although not hidden to any extent by the foliage. He described, as illustrating the fact of the bird's consciousness of its protective coloration, the habit the Cuban meadow lark has of turning its back to the observer, and also the instance related by Mr. W. H. Hudson, in his Argentine Ornithology, of a wounded bittern which persisted in turning its breast toward its captor, although he endeavored to pass around behind it. The bird, with its slender neck pointing straight upward, could not be distinguished from a seed stalk, except on close scrutiny. Mr. Chapman said that Dr. John A. Wells, of Englewood, N. J., had recently watched a woodcock on her nest, and was fully convinced that she was aware of her resemblance to the surroundings, for she remained perfectly quiet and allowed of a very near approach; but when a fall of snow came, and Dr. Wells again visited the sitting bird—now a very conspicuous object—she flew before he had approached within gunshot. The most notable example of protective mimicry is the European cuckoo, which, by reason of its striking resemblance to a hawk, is able to deposit its eggs in the nests of other birds, while they chatter and scold at a respectful distance. Together with many other notices of this kind, the Abstract of Proceedings contains a paper by Tappan Adney giving a list of bird names, etc., of the Milicete Indians of the St. John Valley, New Brunswick.

Measuring the Heights of Clouds.—Four methods of measuring cloud heights have been used at Blue Hill Observatory, Massachusetts: 1. The bases of the lowest clouds frequently float below the summit of the hill (one hundred and twenty-six metres above the general surface of the surrounding land), and the altitude of the base can be ascertained by walking down the side of the hill. 2. Measurements of the angular altitude of the light reflected from clouds floating over adjacent cities can be used for determining the height of the clouds. 3. The shadows of detached clouds can be seen from Blue Hill for many miles moving across the surface of the country, and, by timing the movements of the shadows between points whose distance apart is known, the velocity of the cloud can be ascertained. From the actual velocity and the angular velocity of the cloud its height can be determined. 4. Simultaneous angular measurements of the altitude and direction of the same cloud-point have been made at two stations eleven hundred and seventy-eight metres apart. An attempt has also been made to determine the height

of low clouds by the difference in relative velocity between observations at the base and summit of Blue Hill, but the difference in height (one hundred and twenty-six metres) was found too short for this purpose. The four different methods mentioned to a large extent supplement one another.

NOTES.

THE rare instance of the coming of age of a whole trio of triplets was celebrated recently at Whitenast, near Leamington, England. Generally, in case of triplets, the children die soon after birth, but occasionally they survive and reach maturity. One case is on record of quadruplets, all of whom were reared.

ATTENTION has been called to the cheapness of life in Italy by the light sentence of a few years' imprisonment recently imposed upon a native who, in a fit of jealousy, murdered a physician innocent of all offense. Jealousy is practically accepted by Italian juries as a part expiation of crime, and their misled verdicts are styled verdicts of the heart. Consequently, Italy heads the list of European countries for homicides, and the *vendetta* flourishes there unchecked. A story is told of a Neapolitan who, wishing to kill his wife, would not venture upon the act at home, where he might be guillotined, but removed to Florence, where the penalty was imprisonment for life. Since then imprisonment has been made the penalty throughout the country.

NOVEL uses said to have been found for aluminum are for a folding pocket scale, one metre long; a necktie made of metal, frosted or otherwise ornamented, in various shapes imitating the ordinary silk or satin article, which is recommended for summer wear; and military helmets.

A LARGE trade, according to Mr. John Wallace, is done in the shipment from Washington ports of salmon frozen solid and packed tightly in refrigerator cars in sawdust, without ice. The cars are first reduced in temperature as low as possible, and the floors are covered with *chilled* sawdust. The boxes of fish are next placed therein, any spaces between them being filled with the cold sawdust. The car is then closed and sealed, and in reasonably warm weather its contents may be relied upon to arrive at their destination in the most perfect condition after a passage of eighteen days or thereabouts.

THE mean cloud velocities at Blue Hill, Mass., indicate that the entire atmosphere, from the lowest to the highest cloud level, moves almost twice as fast in winter as in summer. The mean velocity of the highest clouds in winter is more than fifty metres per second, or a hundred miles an hour; and the highest velocity, a hundred and three metres per second, or two hundred and thirty miles per hour, show that the upper currents sometimes move with enormous rapidity.

THERE was a discussion once in The Popular Science Monthly regarding the position assumed by flamingoes in incubating—some authors affirming that they straddled their raised nests, their legs dangling down on either side, and others that they disposed of their legs in some other way. The question seems now to be settled by Abel Chapman, in his book, Wild Spain, who observed them in their nesting grounds on a low mud island of the Andalusian *marisma*, "most distinctly" from a distance of about seventy yards—"the long red legs doubled under their bodies, the knees projecting as far as or beyond the tail, and their graceful necks neatly curled away among their back feathers, with their heads resting on their breasts—all these points were unmistakable."

THE Dutch, desiring to utilize their windmills and at the same time place them in line with the latest improvements in the applications of power, have offered, through the Haarlem Society for the Encouragement of Industry, a prize of $150 to the author of the best essay on the production of electricity through their agency.

A SUBSTITUTION of camels as working animals for horses and oxen has been going on for a few years past in several provinces of Russia, and they are now common on many large estates and on smaller properties. They perform all the work in farming for which horses and oxen are used, as well as being efficient in transportation. A camel market has grown up at Orenburg, and the animals bring sixty or seventy rubles, or about thirty-five dollars, delivered at Kiev.

THE Baluban tribe of Central Africa are famous for their skill in casting and forging iron. They construct tall cylindro-conical furnaces of clay with tuyères of clay and an ingeniously devised wooden bellows. They make arms for hunting and for war, and collars and bracelets of iron. The neighboring natives resort to them in great numbers to exchange their own products for the manufactures of the Balubans.

MORE than three hundred species of fish hitherto unknown to naturalists are described by M. Léon Vaillant as inhabiting the lakes of Borneo. Many other fish are identical with species living in the waters of the Sunda Islands and of Indo-China. As these species never reach the sea, they furnish another argument in favor of the theory of a former connection of these countries.

PROF. EUGENE SMITH, State Geologist, shows in a paper on the Clays of Alabama,

read before the Industrial and Scientific Society of that State, that besides its riches of coal and iron, the State has clays of quality suitable for the manufacture of every kind of brick and stoneware. They are not yet developed, for want of skilled and experienced workmen, and because the world is not acquainted with their qualities. The different clays and their location are fully described in the paper.

THE Arago prize of the French Academy of Sciences has been awarded to Prof. Barnard and Prof. Asaph Hall.

THE Geological and Natural History Survey of Minnesota has begun the publication of bulletins embodying from time to time such discoveries as may be made or scientific contributions presented as they occur, without waiting for the slower publication of the formal reports. The first of the series of botanical studies, Bulletin No. 9, contains five papers of interest in that branch of the survey. The Bulletin will be continued in occasional parts till a volume is completed.

OBITUARY NOTES.

COLONEL ALFRED BURDON ELLIS, commander of the successful British expedition against the Sofas in Africa and a valued contributor to The Popular Science Monthly, died at Teneriffe, March 5th, of African fever. He was the only surviving son of the late Lieutenant-General Sir Samuel Burdon Ellis, and was born in 1852. He entered the British army in 1872, and became a captain in the First West India Regiment in 1879, major in 1884, and lieutenant-colonel in 1891. During twenty-two years he saw a great deal of active service in Africa. He served in the Ashantee war and received a medal; commanded the Houssa Constabulary in 1878; was employed in the Intelligence Department during the Zulu war; was the leader of the expeditions to Tambi (Sierra Leone) and Toniataber (Gambia) in 1892, and for the latter received a medal with clasps; was civil commandant of Sekondi and Chamer on the Gold Coast in 1874, district commander of Quittah in 1878, and of Accra in 1879; was chief officer of the troops on the Gold Coast in 1882 and 1886; and was commandant in the Bahamas in 1889 to 1891, when he was appointed to the command of the troops in West Africa, with the local rank of colonel. In 1892 he administered the government of Sierra Leone. The last of his dispatches concerning the expedition against the Sofas was dated January 29, 1894. A few days after his return to Sierra Leone from this expedition he was attacked with fever, and was removed to Teneriffe. He was the author of A History of the Gold Coast, The Ewe-speaking Peoples of the Gold Coast of West Africa, The Tshi-speaking Peoples of the Slave Coast of West Africa, and of the following articles in The Popular Science Monthly: A Letter on the Lucayan Indians, vol. xxxvi; The Indwelling Spirits of Men, vol. xxxvi; On Vodu-worship, vol. xxxviii; Survivals from Marriage by Capture, vol. xxxix; On Polyandry, vol. xxxix; The Great Earthquake of Port Royal, vol. xl; Marriage and Kinship among the Ancient Israelites, vol. xlii; and White Slaves and Bond Servants in the Plantations; besides which we have others on hand awaiting publication.

DR. H. C. GEORGES POUCHET, Professor of Comparative Anatomy in the Museum of Natural History, Paris, died March 29th in that city. He was the son of the Félix Pouchet who distinguished himself several years ago in the controversy respecting spontaneous generation, and was born in Rouen in 1833. He became assistant naturalist and head of the anatomical department in 1865. He was retired in 1869 in consequence of the publication of some article relating to the Museum of the School of Agronomy, but was raised in 1875 to the position he occupied at the time of his death, succeeding Paul Bert. He was the author of numerous works of scientific value, among which were his doctor's thesis on the Coloration of the Epidermis and his *Traité d'Ostéologie comparé*. He was also a writer in literature of considerable productiveness and high reputation.

MR. WILLIAM PENGELLY, F. R. S., who recently died in England, was a local geologist of much and excellent reputation. He contributed greatly by the results of his personal researches to the work of Lyell, Murchison, and others in establishing English geology. He continued the exploration of Kent's Cavern, under the direction of the British Association, through sixteen years. Besides many other geological papers, he prepared, in connection with Dr. Oswald Heer, a monograph on The Lignite Formation of Bovey Tracey, Devonshire. He collected and arranged the Devonian fossils of the Pengelly Collection, now at Oxford. He originated the Torquay Natural History Society, and in 1862 founded the Devonshire Association for the Advancement of Science, Literature, and Art. He was Fellow of the Royal and Geological Societies, and an honorary member of the Société d'Anthropologie of Paris.

PAUL JABLOCHKOFF, a distinguished Russian electrician and inventor of the electric lamp which bears his name, died in Saratov, Russia, early in April. He was an officer in the Russian army, and was the first person who succeeded in dividing the electric current satisfactorily. His system of electric lighting has been used in several cities of Europe, and for a considerable time the great thoroughfares of Paris, near the Opera, were illuminated with his carbons.